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J. S. James.

AN

ANALYTICAL COMPENDIUM

OF THE

VARIOUS BRANCHES

OF

MEDICAL SCIENCE.

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ANALYTICAL COMPENDIUM

OF THE

VARIOUS BRANCHES

OF

MEDICAL SCIENCE,

FOR THE

USE AND EXAMINATION OF STUDENTS.

BY

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WITH THREE HUNDRED AND SEVENTY-FOUR ILLUSTRATIONS.

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PREFACE

TO THE NEW EDITION.

The speedy sale of two large editions of this work has afforded to the authors gratifying evidence of the correctness of the views which actuated them in its preparation. In meeting the demand for a new edition, they have therefore been desirous to render it more worthy of the favour with which it has been received. To accomplish this, they have spared neither time nor labour in embodying in it such discoveries and improvements as have been made since the appearance of the last edition, and such alterations as have been suggested by its practical use in the class and examination room. Considerable modifications have thus been made throughout all the departments treated of in the volume, and a number of new illustrations introduced, which, together with the pages, have been numbered continuously. The slightly increased size

of the page has enabled the authors to introduce much new matter without increasing the bulk of the volume, and thus detracting from its convenience as a "hand-book."

They again submit their work to the profession, with the hope that their efforts may tend, however humbly, to advance the great cause of medical education.

PHILADELPHIA, March, 1856.

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ANATOMY.

Anatomy is the science which investigates the structure and organization of living beings.

Special Anatomy or *Descriptive Anatomy* is the consideration of each organ or part of the human body, including its size, weight, colour, shape, &c.

General Anatomy investigates the different tissues or structures out of which organs are formed.

Surgical Anatomy or *Regional Anatomy* is the study of the relation of one part to another, and is one of the most important applications of anatomy to the practice of medicine and surgery.

Physiological Anatomy considers the uses and functions of organs in a healthy state.

Pathological Anatomy regards the different organs altered by disease.

This is a compendium principally of special anatomy; and is divided into seven sections:

1. Bones.
2. Ligaments.
3. Muscles.
4. Viscera.
5. Vessels.
6. Nerves.
7. Special Senses.

SECTION I.

BONES.

GENERAL CONSIDERATIONS OF BONE.

The bones of the *skeleton* are two hundred and eleven in number, of which twenty-two belong to the head, fifty-six to the trunk, sixty-nine to the superior and sixty-four to the inferior extremity; when held together by ligaments and cartilages they form a natural skeleton, when by other means an artificial skeleton. They are hard, white, and inflexible; and more numerous in childhood than in old age.

They are *classified* into long, thick, and flat bones. The body or shaft of a long bone is called Diaphysis; its articulating extremities, Epiphyses; its processes and projections are called Apophyses. The small foramina on the surface of bones are for the transmission of nutritious vessels, the largest of which enters about the middle.

Bones are composed of two *structures*, *compact* and *cellular*. The compact structure consists of small fibres arranged in laminæ; each of these fibres has a canal running through its length, called the canal of Havers, transmitting vessels; it communicates with small lenticular excavations, called *corpuscles of Purkinje*, by radiating tubes. The cellular structure increases the volume and strength without increasing the weight, and also diminishes the effect of concussion. The cells communicate with each other, and contain marrow.

Composition of Bones.—Bones are chemically composed of animal and earthy matters, united in the proportion of two parts of earthy to one of animal. By the analysis of Berzelius, they consist of thirty-two parts of gelatine, one part of insoluble animal matter, fifty-one parts of phosphate of lime, eleven of carbonate of lime, two of fluate of lime, one of phosphate of magnesia, and one of soda and muriate of soda. The earthy matter is most abundant in bones of the cranium: the animal matter in the cellular structure. Combustion will remove the animal matter, and dilute acids will remove the earthy matter.

The *Periosteum* is a white fibrous membrane investing the external surface, adhering less firmly in infancy, and becoming ossified in old age. It is vascular, insensible in health, assists in the secretion of the external laminæ, restrains ossification within proper limits, receives the insertion of muscles, tendons, &c., and protects the bone from suppuration in the vicinity.

Marrow is contained in a fine vascular membrane, lining the medullary canals and cells of bones, called the *Internal Periosteum*. It

resembles fat, but consists of finer granules; in consumption, dropsy, &c., it is absorbed and its place is supplied with serum.

Formation and growth of bones.—There are three stages of ossification in the embryo. The first is the mucous or pulpy, which continues for one month; the second is the cartilaginous, and the third the osseous, commencing at the third month. The colour of the cartilage deepens and then a vessel conveys red blood to a central point, which first receives calcareous particles and is called *punctum ossificationis.* Bones increase in length by continued deposit at their extremities between the Diaphysis and the Epiphyses, as is proved by Hunter's experiment of placing two shot in the tibia of a young pig; after the animal had reached full size, the shot were found at their original distance from each other. Bones increase in thickness by external deposit and by secretion from the periosteum, which is proved by disease and the experiment of feeding a young pig with food coloured with madder. Various laminæ of white and coloured bone can be produced by suspending and resuming this mode of feeding. While deposit is taking place upon the surface of a bone, absorption is going on internally; this is proved by Duhamel's experiment of surrounding a long bone of a young animal with a metallic ring; after the animal was fully grown, the ring was found in the medullary canal, which increases in size by this constant deposit and absorption.

BONES OF THE TRUNK.

The trunk consists of the Spine, Pelvis, and Thorax.

SPINE.

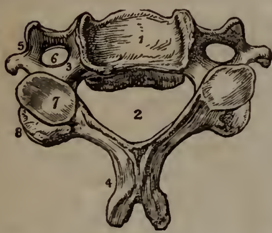
It extends from the head to the coccyx at the posterior part of the trunk, having several curvatures. In the neck it is convex anteriorly, in the thorax concave, in the loins convex, and in the pelvis concave. It contains an osseous canal for the spinal marrow, and is formed of 28 or 29 separate bones, called *vertebræ*, 24 of which are classified as *true vertebræ*, on account of their mobility, and the 5 remaining are called *false vertebræ.* The true vertebræ are divided into 7 *cervical,* 12 *dorsal*, and 5 *lumbar;* the false vertebræ consist of the sacrum, and 3 or 4 coccygeal bones.

A vertebra consists of a body, 7 processes, and a spinal foramen. The *body* is in front, and is the thickest part; its upper and lower surfaces articulate with a contiguous vertebra by means of a cartilage; it is convex anteriorly from side to side. The *processes* are, one *spinous*, of a triangular shape, and situated behind for the attachment of muscles; two *transverse,* one projecting horizontally on either side for the attachment of muscles and ligaments; and four *oblique* processes, two of which are superior and two inferior, which are for the purpose of articulation. The *spinal foramen* is in the middle, and constitutes

a portion of the spinal canal. The *intervertebral foramen* is formed on each side by a groove upon the upper and lower surface of each vertebra, and transmits a spinal nerve.

CERVICAL VERTEBRÆ.

Fig. 1.



The *bodies* are small, and flattened in front; the superior surfaces[1] are concave laterally, the inferior are concave antero-posteriorly; they gradually increase in size. The *spinous processes*[4] are short, thick, horizontal, and bifid. The *oblique processes* are flat, oval, and short; the *superior*[7] look upwards and backwards, and the *inferior*[8] downwards and forwards at an angle of forty-five degrees. The *transverse processes*[5] are broad, perforated at their base by a foramen[6] for the transmission of the vertebral artery. The *spinal foramen*[2] is very large and triangular.

The *first cervical vertebra* is called the *atlas;* it has no body, and resembles a ring. In place of a body, there is an arch which has a tubercle in the middle of its anterior surface; in the corresponding part of its posterior surface is an articular fossa for the *processus dentatus* of the second vertebra. The posterior arch has a tubercle instead of the spinous process. The *superior oblique processes* are large, oblong, and concave, adapted to the condyloid processes of the occiput; and admit of flexion and extension. The *inferior oblique processes* are round, flat and horizontal, adapted to the rotatory motion of the head. The transverse process is extremely long. On the inner side of the oblique processes is a tubercle for the attachment of the transverse ligament. It has the largest *spinal foramen.*

The *second* cervical vertebra is called *dentata*, from its tooth-like process projecting from the upper surface of the body; the tip of which is rough for the middle straight ligament, and on the sides of the tip there is a flatness for the attachment of the moderator ligaments. This process is smooth in front where it touches the arch of the atlas and also behind where the transverse ligament plays. Upon this process the head rotates. The *superior oblique process* is circular and slightly convex. The *spinous* process is long and bifid.

The *sixth* has a long and pointed *spinous* process.

The *seventh* is the largest and resembles a dorsal. The spinous process is the longest and tuberculated. The foramen at the base of the transverse process does not transmit the vessels.

DORSAL VERTEBRÆ.

These are twelve in number. The *bodies*[1] are cylindrical, and their

transverse diameter decreases from the first to the third, and then increases. The upper[3] and lower surfaces are flat, and the sides have articular marks[2] for the heads of the ribs. The fossa for each is formed by two contiguous vertebræ. The *oblique* processes are vertical, the superior[8] looking backwards and the inferior[9] looking forwards. The *transverse* processes[7] are long, and their extremities are enlarged; in front there is an articular face for the tubercle of the rib. The *spinous* processes[5] are long and triangular, broad at the base, sharp-pointed, and overlap each other. The spinal foramen is small and round. The intervertebral foramen is mainly formed by the inferior groove,[5] which is much deeper than the superior.[4]

Fig. 2.

The *first* has a complete fossa for the head of the rib upon its side. The *eleventh* and *twelfth* have also complete fossæ for the heads of the ribs. Their transverse processes are short, directed backwards, and do not articulate with the ribs.

LUMBAR VERTEBRÆ.

Their number is five. The *bodies* are large and oval, the transverse diameter being the longest. The spinal foramen is triangular and large. The grooves[3] [4] forming the intervertebral foramen are also large. The *oblique* processes are vertical; the superior[7] looking inwards and the inferior[8] looking outwards. The *transverse* processes[6] are long and at right angles. The *spinous*[5] processes are short, thick, quadrangular, and horizontal.

Fig. 3.

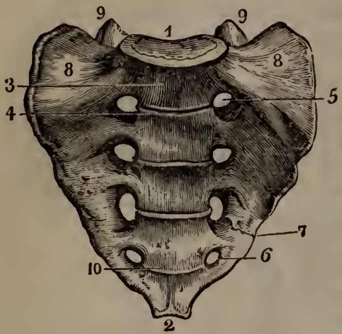
The *first* is the smallest; the *third* has the longest transverse process; the *fifth* has a wedge-shaped body.

SACRUM.

Is triangular, and originally consisted of five pieces; its *anterior surface*[3] [10] is concave, with four funnel-shaped holes[5] [6] on each side, transmitting the anterior branches of the sacral nerves. Its *posterior surface* is rough and convex, and contains the representations of spinous and oblique processes. A fissure usually exists in place of the fourth and fifth spinous processes. There are four foramina on each

side, smaller than those in front, for the transmission of the posterior branches of the nerves. The *base* has a large oval articular mark[1] upon which rests the last lumbar vertebra; it also has two oblique processes,[9] and two grooves completing the intervertebral foramina.[9] The *apex*[2] is blunt and has a transverse articular surface for the coccyx. The *sides* are rough, broader above than below, and have large articular marks for the innominata; behind this surface arise muscles of the back, and below it the sacro-iliac ligaments. The *sacral canal* runs through the length of the sacrum. It is triangular, larger above than below; and is continuous with the spinal canal. It contains the cauda equina; and with it communicate the foramina transmitting the nerves.

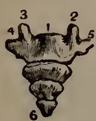
Fig. 4.



COCCYX.

The coccyx is flat and triangular, having its base upwards. It consists of three or four bones united usually in the same curve as that of the sacrum. The pieces are frequently united with each other and the sacrum.

Fig. 5.



The *first* piece[1] is the largest, and has two articular marks; behind, it has two *cornua;*[2 3] on its side is a groove,[4 5] which with the sacrum completes the canal for the fifth sacral nerve. The *last piece*[6] is a mere tubercle. The sides of the coccyx give origin to muscles and ligaments.

PELVIS.

The pelvis consists of the *sacrum, coccyx,* and the *two innominata* or hip bones.

INNOMINATUM.

This is a large flat bone forming the haunch or hip of common language, resembling in some measure the figure 8. In youth it consists of three different parts, united in the acetabulum, viz., the ilium, ischium, and pubes.

Ilium.—This is the largest piece, and forms the wall of the upper pelvis. Its *external* surface is convex and rough, with a semi-circular ridge crossing it; above this ridge arises the gluteus medius, and below it the gluteus minimus muscle; the posterior part of this surface is the roughest, and gives origin to the gluteus maximus.

Fig. 6.

The anterior part of the internal surface[6] contains a large, smooth concavity called the costa, which gives origin to the iliacus internus muscle; the posterior is rough and has a large articular mark for the sacrum, behind which arise muscles and ligaments. The *edge* or *crista* is arched and curved like the italic *f*. In front there are two eminences, one of which is called the *anterior superior spinous process*,[7] giving origin to the sartorius and tensor vaginæ muscles and Poupart's ligament; the other is the *anterior inferior spinous process*,[8] and gives origin to the rectus muscle; the space between the two gives origin to the gluteus medius. Below these processes is a large prominence[n] called *ilio-pectineal;* in the groove above this pass the iliacus internus and psoas magnus muscles. The posterior *superior* and *inferior spinous* processes are behind, and to them are attached ligaments. The *crista* has three lips, from the internal of which arises the transversalis muscle, from the middle arises the internal oblique, and into the external is inserted the external oblique. The inferior border of the ilium presents a *notch*,[p] called *sciatic.*

Ischium. — This is the most inferior part of the innominatum. It consists of a body and a branch; the external surface of the body[b] is rough; the internal surface is smooth, and is called the *plane* of the ischium. The posterior border presents a projection called the *spine*,[d] into which is inserted the lesser sacro-sciatic ligament, and beneath the spine is a groove in which plays the tendon of the obturator internus muscle. The inferior portion of the body is called the *tuberosity*,[c] from which arise the semi-membranosus, semi-tendinosus, and the long head of the biceps muscles; in front there is a ridge into which is inserted the greater sacro-sciatic ligament; outside of the ridge is the origin of the adductor magnus muscle.

The *ramus* or branch is short and thick, and ascends forward and inward, joining the ramus of the pubes, and forming a portion of the pubic arch;[9] externally it is rough, and internally it is smooth, whence arises the crus of the penis.

Pubes.—It forms the anterior boundary of the pelvis, and consists of a *body*[e] and descending *ramus* or *branch.*

The *body* articulates with its fellow by a vertical surface,[f] called the *symphysis.* The superior portion of the body at right angles with the symphysis is *horizontal,*[h] and limited externally by a projection[i] called the *spinous process;*[i] from this process there diverge two ridges; the posterior[k] is sharp and called the *crista of the pubes,* or *linea pectinea;* to it is attached a portion of Poupart's and Hey's ligament. Between these ridges is included a triangular space,[o] the base being the ilio-pectineal eminence,[n] and the apex of the spinous process; from this space arises the pectineus muscle, and over it pass the femoral vessels. The anterior ridge terminates at the acetabulum.

The *ramus* descends to join that of the ischium, and forms a part of the pelvic arch; externally it is rough for the origin of the abductor muscles; internally it is smooth, and to it is attached the crus of the penis.

The *acetabulum,*[9] is a deep hemispherical concavity upon the outer side of the bone for the articulation of the head of the femur. The brim of this cavity is notched on the lower edge. In the bottom of the cavity is a rough depression occupied by a mass of fat, commonly called a gland of Havers. Immediately beneath the acetabulum is a groove, in which plays the tendon of the external obturator muscle.

The *obturator* or *thyroid foramen,*[d] is that large opening in the front and lower part of the bone, which is filled up by a membranous ligament, with the exception of a groove at its upper part, through which pass the obturator vessels and nerve. Its shape is oval in males, but triangular in females.

THORAX.

This cavity is formed by the dorsal vertebræ, ribs and sternum; its figure is conoidal, flattened in front, and concave behind; the apex presents a cordiform opening, and the opening at the base has a large notch in front.

STERNUM.

Is an oblong, slightly-curved bone, placed in front of the thorax. Usually it consists of three pieces, but in advanced life of but one.

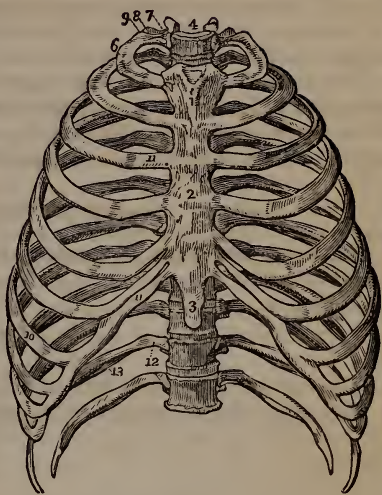
The *first* or superior bone,[1] is the thickest, and resembles in shape a triangle, with the corners cut off, the base being upwards; on the superior edge is a concavity for the benefit of the movements of the trachea; on each side is a large concavity for the articulation of the clavicle, and below are two smaller ones for the articulation of the cartilage of the first and part of that of the second rib.

Sometimes there are found upon the upper edge of the first bone two small spherical bones called *Episternal bones.*

The *second* bone[2] is longer and narrower than the first, increasing in breadth in its lower extremity; its sides present pits for the articulation of the cartilages of part of the second, the third, fourth, fifth, sixth, and part of the seventh ribs.

The *third* bone,[3] is very frequently cartilaginous, and called xyphoid or ensiform; its shape varies, sometimes being pointed, and sometimes bifurcated; upon its side is a depression for a portion of the seventh rib.

Fig. 7.



RIBS.

These are twenty-four in number, twelve on either side; those that articulate with the sternum are called *true* ribs, and are seven in numbes; the five below them are called *false* ribs: in some rare instances there have been thirteen or eleven ribs on one side. They are parallel, and directed obliquely downwards and forwards; each having a parabolic curve, and gradually increasing in size until the eighth, afterwards gradually diminishing.

The *anterior* or *sternal* extremity[11] is larger and flatter than the *posterior;* the *posterior* or *vertebral* extremity presents a spherical head, having two articular surfaces separated by a ridge. The *neck* of the rib is very narrow and its upper edge, which is sharp, has inserted into it the *internal costo-transverse* ligament; about one inch from the head is the tubercle, a prominence with an articular face, for articulation with the transverse process of the vertebra; just beyond this is a smaller tubercle, for the insertion of the *external costo-transverse* ligament.

Each rib is twisted and bent; this bend constitutes the *angle* of the rib; upon the external surface of the angle is a mark showing the insertion of the sacro-lumbalis muscle. The *lower* edge of the rib is thin and cutting, and just within it is a groove,[13] running two-thirds of its length, and containing the intercostal vessels and nerve. The *upper* edge is rounded, and upon it are inserted the intercostal muscles.

The *first* rib[8] is small and semicircular, its surface looking superiorly and inferiorly; the superior surface has upon its middle a slight fossa,

for the subclavian artery: in front of this is a roughness for the insertion of the scalenus anticus muscle, behind it another for the insertion of the scalenus medius; the head has a single articular surface, its angle is at the tubercle, and it has no intercostal groove.

The *eleventh* and *twelfth*,[12] are called *floating* ribs, because they are not connected with the others; they have no tubercles, and their heads have but a single articular surface. The twelfth is very short, but slightly curved, and has no intercostal groove.

BONES OF THE HEAD.

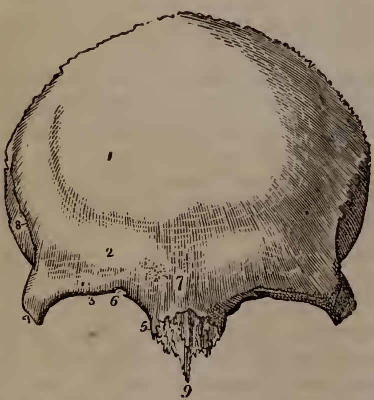
These are twenty-two in number, and are divided into those of the cranium, which are eight in number; and those of the face, which are fourteen.

CRANIUM.

FRONTAL BONE.

This forms the forehead. It is usually a single, symmetrical bone, though occasionally divided by a suture into two parts. Its shape resembles that of a shell.

Fig. 8.



The *external surface* is convex, and about the middle upon each side there is the *frontal protuberance*,[1] being the original centre of ossification; below this and nearer the median line is an oblique ridge called the *nasal* or *superciliary protuberance*.[2] The inferior edge of the bone is formed on either side by the *orbitary ridge*,[3] forming the superior boundary of the orbit of the eye; this ridge is terminated outwardly by the external angular process,[4] just within which is a depression for the lachrymal gland, and inwardly by the internal angular[5] process; between the internal angular processes is a prominence called the *nasal spine*,[9] which serves as an abutment for the nasal bones. Upon this orbitary ridge, half an inch distant from the internal angular process, a small depression exists, upon which plays the tendon of the superior oblique muscle; to the outside of this depression is a notch or foramen, for the transmission of the supra-orbital artery and nerve.[6]

The *frontal sinus*[7] opens near the internal angular process, and is formed by the separation of the tables over the orbitary ridge; its

capacity varies, and there are no means of determining it in the living being; it empties into the infundibulum, one of the anterior cells of the ethmoid.

The *internal surface* is concave and has numerous depressions corresponding with the convolutions of the brain; in the middle is a fossa for the superior longitudinal sinus, and a ridge for the attachment of the dura mater; at the bottom of this ridge is the *foramen cæcum*, transmitting a vein, which forms the commencement of the sinus.

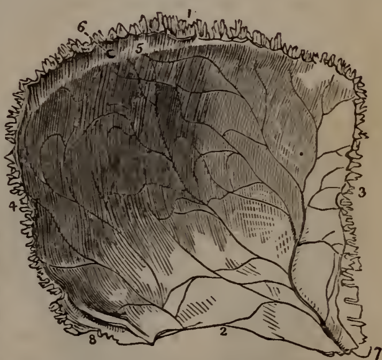
The *orbitar processes* are two horizontal plates, forming the roofs of the orbits, separated by a large space, which is occupied by the ethmoid bone. The *internal* edges of these processes have two grooves, which are converted into foramina, called ethmoidal or orbitary, by the articulation of the ethmoid. Each transmits an artery and a vein to the nose. The *anterior ethmoidal foramen* also transmits the internal nasal nerve.

Laterally the bone articulates with the parietal and sphenoid, inferiorly with the bones of the face and with the ethmoid.

PARIETAL BONES.

These occur in pairs, and form the middle and lateral portions of the cranium; they are quadrangular.

Fig. 9.



The *external surface* is convex, has in its middle the parietal protuberance, the centre of ossification; below this is the semicircular ridge indicating the attachments of the temporal fascia and muscle.

The *internal surface* is concave, with numerous depressions for the convolutions of the brain, and is also traversed by furrows showing the course of the middle artery of the dura mater. The *superior* edge[1] is the thickest and much dentated; when adjusted with its fellow, it forms a deep groove for the longitudinal sinus.[5] The parietal foramen,[6] transmitting a vein, opens into this groove. The *inferior* edge[2] is short, concave, and squamous, articulating with the temporal. The anterior inferior angle[7] is long and pointed, articulating with the great wing of the sphenoid; the posterior inferior[8] angle is very obtuse, and deeply grooved on its internal surface for the lateral sinus.

OCCIPITAL BONE.

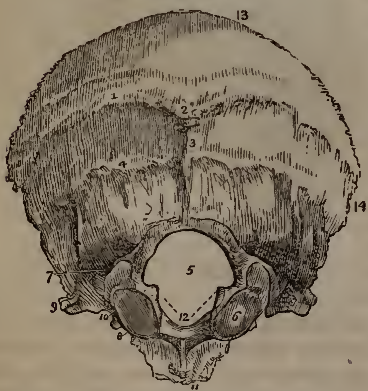
This is placed at the posterior and inferior part of the head, and is of an oval or trapezoidal shape.

The *external surface* is convex, and in some parts rough; near its middle is a prominence called the *external occipital cross*,[2] from which there proceeds on each side a semicircular ridge,[1] to which is inserted the sterno-cleido-mastoideus muscle, and from which arise the trapezius and occipital frontalis. About one inch below is another semicircular ridge[4] for the insertion of the superior oblique muscle. Between this ridge and the foramen magnum, the space is occupied by the recti postici muscles. Reaching from the external occipital cross is a vertical ridge[3] extending to the foramen magnum, to which is attached the ligamentum nuchæ. The space between the superior and inferior semicircular ridges is occupied by the insertion of the splenius and complexus muscles.

The *foramen magnum*[5] is oval, its antero-posterior diameter being the largest; it transmits the medulla oblongata, spinal accessory nerves, and vertebral artery. On either side of the foramen is the *condyloid process*,[6] an oblong convex surface converging towards its fellow, and articulating with the atlas. It is frequently divided by a ridge or groove, especially in the young African head. The *anterior condyloid foramen*[8] transmits the hypoglossal or ninth nerve, the *posterior condyloid foramen*[7] a vein to the lateral sinus.

In front of the foramen magnum is the *basilar process*,[11] the extremity of which articulates with the sphenoid; the inferior surface receives the insertion of the recti postici and superior constrictor muscle of the pharynx; the superior surface is concave and contains the medulla oblongata.

Fig. 10.



The *internal surface* is concave and about its middle has an *internal occipital* cross, which is more prominent than the external; from it there diverge three grooves, containing the two lateral and the superior longitudinal sinuses; inferiorly there proceeds a ridge to the foramen magnum to which is attached the falx cerebelli. The concavity is thus divided into four smaller ones; the two superior, containing the posterior lobes of the cerebrum, and the two inferior containing the hemispheres or lobes of the cerebellum.

The two superior edges are deeply dentated and articulate with the parietal; the two inferior articulate with the temporal. On each inferior edge is a prominence called the *jugular eminence*,[9] in front of which is a fossa converted into the *posterior foramen lacerum*[10] by articulation with the temporal, through which pass the internal jugular vein and the eighth pair of nerves. Upon the inferior surface of this eminence is inserted the rectus capitis lateralis.

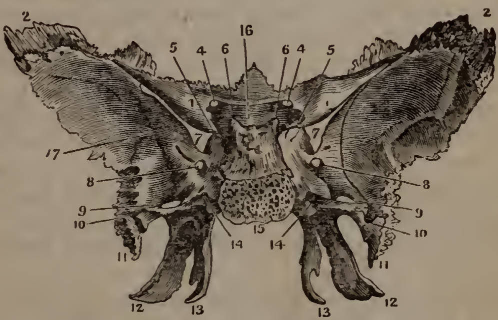
SPHENOID.

Situated in the middle and anterior part of the base of the cranium. The shape resembles a bat. It consists of a body and four wings; a large and small one being placed on each side, besides two vertical processes directed downwards.

The *body* is in the centre and cuboidal in its shape. On its *superior* surface is a deep pit called *sella turcica*,[16] which contains the pituitary gland. This depression is overhung posteriorly by the *posterior clinoid process*;[6] on either side are two grooves called *sulci carotici*, for the carotid arteries, and in front there is a prominence called *processus olivaris*, upon which is a transverse groove indicating the position of the chiasm of the optic nerves.

On the anterior view of the body are the orifices of the two sphenoidal cells, separated by a ridge, upon which articulates the nasal

Fig. 11.



lamella of the ethmoid bone. These cells empty into the posterior ethmoidal cells, and do not exist in infancy. The inferior surface of the body has an elevation in the median line called the *processus azygos*, by which it articulates with the vomer. Posteriorly, the surface[15] is rough for articulating with the cuneiform process of the occipital bone.

The *small wings*[1] are placed in front of the large. They are triangular, flat, and narrow. Their posterior extremities constitute the

anterior clinoid processes[5] which are perforated by the *optic foramina*,[4] through which pass the optic nerves and ophthalmic arteries. They articulate in front with the frontal bone.

The great wings are separated from the small by the *sphenoidal fissure* or *foramen*,[7] which transmits the third, fourth, first branch of the fifth, and the sixth nerves.

This wing has three surfaces. The *cerebral*[17] is concave and has numerous depressions for the convolutions of the middle lobe of the cerebrum which lodges in this concavity. It has three foramina. The foramen *rotundum*[8] transmits the second branch of the fifth pair. Behind it, is the *foramen ovale*,[9] through which passes the third branch of the fifth pair. The posterior angle of this surface is the spinous process, which is perforated by the *foramen spinale*,[10] by which the the middle artery of the dura mater enters the cranium. Projecting from the inferior surface of this process is another called *styloid*,[11] which gives origin to muscles.

The external surface is the *temporal*, which is divided by a ridge, and has a process in front; it is covered by the temporal and external pterygoid muscles. The anterior surface is called the *orbital*, forming a large portion of the orbit of the eye. On the superior surface is a large, triangular, serrated surface,[2] for articulating with the frontal bone. Laterally it articulates with the temporal.

Pterygoid processes. — These project downwards on either side in a line parallel to the facial line, and articulate with the palate bones in front. Posteriorly, there is a fossa called pterygoid, which terminates in a notch, and divides the process into an *external* and *internal plate*. The *external*[12] is the broader, and gives origin to the external pterygoid muscle; the *internal*[13] is the longer, and terminates in a hook-like process, called the *hamulus*, over which plays the tendon of the circumflexus palati muscle. The internal plate gives origin to the internal pterygoid muscle, which occupies a portion of the fossa.

The internal surface of the base of the pterygoid process has a groove upon it, showing the course and connexion of the cartilaginous portion of the Eustachian tube. The *pterygoid foramen*[14] perforates the base of the process, and transmits the Vidian or recurrent nerve.

TEMPORAL BONES.

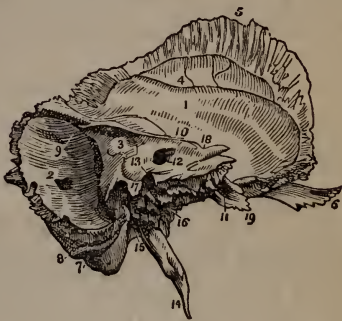
These are placed on either side of the cranium below the parietal bone. They consist of three portions, squamous, petrous, and mastoid.

The *squamous*[1] is thin and shell-like. Its *external* surface is slightly convex, has grooves for the deep temporal artery, and is covered by the temporal muscle. Projecting anteriorly from the lower part of this surface is the *zygomatic process*,[6] which forms a part of the zygomatic arch. The base of this process is triangular, and has beneath it a cavity called glenoid for the articulation of the lower jaw. This cavity is separated by the Glaserian fissure from another behind it,

containing a portion of the parotid gland. Through this fissure pass the chorda tympani nerve, and the laxator tympani muscle attached to the processus gracilis of the malleus. The *internal surface* has a distinct groove[4] for the middle artery of the dura mater. The edge is thin and cutting and has flat serrations[5] for the parietal bone.

The *mastoid* portion is behind, and nipple-like. It is thick and cellular; the cells being lined by a thin membrane. Externally it is rough, and has a large *process* called *mastoid*,[8] upon which are inserted the sterno-cleido-mastoid and trachelo-mastoid muscles. Beneath this process is the *digastric fossa*,[7] which gives origin to the digastric muscle. Internally is a deep sulcus[8] containing a part of the *lateral sinus*. The edges are thick and dentate. Near the upper edge is the mastoid foramen,[2] which transmits a vein.

Fig. 12.



The *petrous*[3] portion is pyramidal and directed obliquely forwards and inwards. Its structure is extremely dense.

The *base* has a large oval opening externally, between the zygomatic and mastoid, called the *external meatus*, which is surrounded by a rim called the *auditory* process, to which is attached the cartilaginous portion of the ear. In the fœtus is a ring. The *apex* is obtuse and is perforated by the carotid canal. In the angle between the apex and the squamous portion of the bone, is the bony portion of the Eustachian tube, and above it a canal for the tensor tympani muscle.

The *inferior surface* presents a large process, *styloid*,[14] projecting from a ridge called the *vaginal process*. Behind it, is the *stylo-mastoid foramen*,[15] the orifice of the Fallopian canal, which transmits the facial nerve and stylo-mastoid artery. Inwards from the styloid process is the *jugular* fossa, which is converted into the posterior foramen lacerum by the articulation of the occipital bone; this foramen transmits the internal jugular vein and the eighth pair of nerves. The *tympanic canal*, containing Jacobson's nerve, opens in this fossa; its other orifice is near that of the Eustachian tube. In front of the jugular fossa is the commencement of the *carotid canal*,[16] which contains the carotid artery and the ganglion of Laumonier. Upon the septum between the jugular fossa and carotid canal, is the entrance to the *aqueduct of the cochlea.*

The anterior surface presents a groove[18] leading to a foramen called *hiatus Fallopii*,[10] which transmits the superficial petrous nerve, a branch

of the Vidian; behind this is the *eminentia arcuata*, made by the prominence of the labyrinth. At the internal edge is a groove for the superior petrosal sinus, and near the apex a semilunar depression for the ganglion of Casser.

The *posterior* surface has a large opening near the middle, called the *internal meatus auditorius*;[12] it is not deep, and the base is cribriform. Immediately above it is a foramen or fissure for the attachment of the dura mater and a small bloodvessel; behind it is a ridge produced by the inferior semicircular canal, and half an inch behind it is the aqueduct of the vestibule, concealed by an osseous lamella.

ETHMOID.

Is so called from its resemblance to a sieve. It is placed in the median line, at the base of the skull, in front of the sphenoid bone, and between the orbitar processes of the frontal. It is cuboidal in shape and cellular in structure.

The *superior* surface is called the *cribriform plate*,[4] which is perforated with holes for the transmission of filaments of the olfactory nerve; the most anterior hole is the largest, and transmits the internal nasal nerve. From the median line is a narrow, triangular, hollow process, called the *crista galli*,[3] and to it is attached the falx cerebri. In front of this is sometimes the foramen or groove called *foramen cæcum*, which admits of the passage of a small vein from the nose.

The bone is divided longitudinally into two halves by the vertical plate of bone called the *nasal lamella*;[1] this can best be seen by examining the inferior surface. It articulates below with the vomer, and behind with the crista sphenoidalis.

The *lateral surfaces* of the bone are called the *ossa plana*.[8] The os planum is extremely thin and papyraceous, forming a large part of the orbit of the eye. On its upper edge are two grooves, which are converted into two *foramina*, called *internal orbitary* or *ethmoidal*; the anterior transmits an artery, vein, and the internal nasal nerve; and the posterior transmits an artery and vein. The inferior edge articulates with the superior maxillary bone. When the bone is viewed from behind there will be seen two scrolls or shells on either side of the nasal lamella, but attached to the internal face of the os planum. They are the *superior*[6] and *middle turbinated bones*,[7] placed one above the other, and separated by a fissure. This fissure is the *superior meatus*[5] of the nose. The *middle meatus* is a space observed in an articu

Fig. 13.

lated head between the middle and inferior turbinated bones. The anterior cells of the ethmoid bone empty into the middle meatus; the most anterior of these cells is funnel-shaped (*infundulum*), and receives the fluid from the frontal sinus; from the inferior part of these cells there proceeds a hook-like process. The posterior ethmoidal cells and the sphenoidal sinus empty in the superior meatus.

In children there is attached to the ethmoid bone, on each side, a hollow triangular process, called the pyramid of Wistar, or cornu of Bertin. The base is connected with the superior turbinated bone, the posterior edge of the cribriform plate, and the posterior edge of nasal lamella. The apex lies under the body of the sphenoid bone, on each side of the processus azygos. These pyramids are detached from the ethmoid in after life, and become the sphenoidal sinuses.

The ethmoid articulates with the frontal, sphenoid, inferior turbinate, upper jaw, nasal, lachrymal, palate bones, and with the vomer.

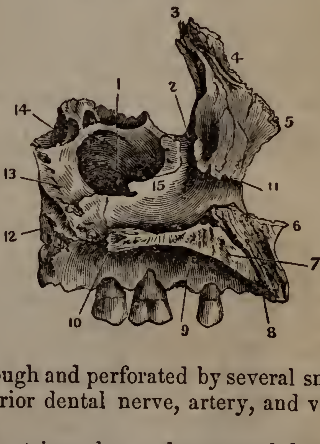
BONES OF THE FACE.

These are fourteen in number, and exist in pairs with the exception of two, the lower jaw and the vomer.

SUPERIOR MAXILLARY BONE.

This with its fellow constitutes the upper jaw. It articulates with all the bones of the face with the exception of the lower jaw. It has an irregular cubical body and four processes. The *body* is hollow and has four surfaces.

Fig. 14.



The anterior or *facial* surface is bounded above by the inferior margin of the orbit, beneath which is the *infra-orbital foramen,* transmitting the infra-orbital nerve, artery, and vein. Contiguous to this foramen is a depression, called the *canine fossa,* which gives origin to the levator anguli oris muscle. The posterior or *temporal* surface is rounded. The most prominent part is called the *tuber,*[12] which is rough and perforated by several small foramina which transmit the posterior dental nerve, artery, and vein, to the floor of the antrum.

The superior or *orbital surface* is triangular, and traversed by the infra-orbital groove leading to the foramen of that name. Upon the internal or *nasal surface* is the large opening of the *antrum High-*

morianum,[1] which is a pyramidal cavity with thin walls; the walls are grooved, indicating the passage of the anterior and posterior dental nerves. The opening is diminished by the articulation of the palate, inferior turbinate, and unguiform bones, to a small orifice which opens into the middle meatus of the nose.

The *nasal process*[4] arises from the superior and anterior part of the bone. It is broad and thin below; externally it gives origin to the levator labii superioris alæque nasi muscle, internally it has a transverse ridge[11] dividing the surface unequally for the inferior turbinated bone. The anterior edge[3 5] articulates with the nasal bone, the superior with the frontal, and the posterior edge[3 2] has a deep groove, which is converted into a bony canal for the lachrymal sac by the articulation of the os unguis.

The *malar process* is a rough process on the external and superior part of the bone for articulation with the malar bone.

The *alveolar process* contains the sockets for eight teeth.

The *palate process*[7] is the horizontal roof of the mouth and floor of the nose; uniting behind with the horizontal part of the palate bone,[10] and on the side with its fellow, from which latter junction or suture there arises the *nasal crista*, for the articulation of the vomer. The anterior extremity[6] is the anterior nasal spine. Immediately behind this is the *foramen incisivum*[8] which contains the naso-palatine nerve and ganglion of Cloquet.

PALATE BONE.

Situated on each side between the superior maxillary and the sphenoid bone; the figure is irregular and consists of three parts.

The *horizontal* part[1] is quadrilateral in its shape and assists in forming the floor of the nostril and roof of the mouth. The suture[4] between it and its fellow forms a part of the nasal crista for the articulation of the vomer, and posteriorly is elongated into the posterior nasal spine; from which arises the azygos uvulæ muscle.

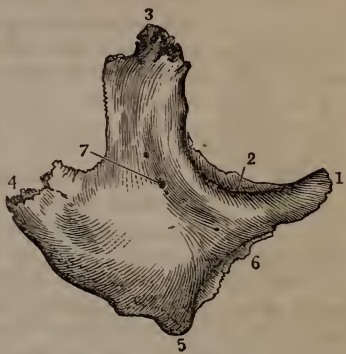
The ascending or *vertical portion*[2] is divided on its internal or nasal face by a ridge,[6] for the articulation of the inferior turbinated bone; externally it has a rough articular surface for the superior maxillary bone; upon this surface is a groove, converted into the posterior palatine foramen or canal by this articulation, which transmits the palatine nerve and artery. Posteriorly there is an elongated triangular process called *pterygoid*;[3] this process has three grooves, the middle of which forms a part of the pterygoid fossa, and those on each side receive the external[10] and internal[11] plates of the pterygoid process of the sphenoid.

Fig. 15.

The upper extremity of this vertical or nasal portion is formed by

two processes separated by a notch which is converted into a foramen, called spheno-palatine,[7] by articulation with the sphenoid bone, and transmits the spheno-palatine artery and nerve. The anterior process is called *orbital*,[8] forming a small part of the orbit between the ethmoid and superior maxillary. The posterior is the *pterygoid apophysis*;[9] it is extremely thin, inclines inwards and fits upon the base of the body of the sphenoid.

Fig. 16.



MALAR BONE.

Is quadrangular in shape, and forms the prominence of the cheek. It consists of a body and processes. The *body* has three surfaces. The external or facial has numerous small perforations for arteries[7] and nerves; the internal or orbital is smooth and has a notch which limits the spheno-maxillary fissure or foramen lacerum inferius of the orbit; the posterior forms the anterior boundary of the temporal or zygomatic fossa.

The *superior process* is the *frontal*,[3] for articulating with the external angular process of the frontal bone. The *temporal process*[4] projects backwards to unite in forming the zygomatic arch. The *maxillary*[5 6] is triangular and rough, for articulating with the malar process of the superior maxillary bone. The bone has four edges. The superior[2] is curved and continuous with the orbital ridge, the inferior gives origin to the zygomatic and masseter muscles, the anterior articulates with the superior maxillary, and the posterior has the temporal fascia connected with it.

The malar bone sometimes contains a cavity called the sinus jugalis, especially in Mongolians and Malays.

NASAL BONE.

These bones unite with each other and are placed between the nasal processes of the superior maxillary bones. The shape is a long quadrangle, but in Africans it is frequently triangular. The superior extremity is narrow and thick, articulating with the frontal bone. The inferior is thinner and broader, having the cartilage of the nose attached; the internal edge articulates with its fellow, and the external has a spiral groove, whereby it is overlapped by the nasal process of the superior maxillary above, and overlaps the process below. The anterior surface has numerous foramina for nutritious vessels; the posterior contains a groove for the internal nasal nerve.

UNGUIFORM BONE.

This is so called from its resemblance to a finger nail (unguis): it is also called lachrymal. It is quadrangular, flat, and small, extremely thin and often cribriform. The external surface[1] forms a portion of the orbit of the eye, and has a groove in front,[2] which completes the canal for the lachrymal sac. From its inferior edge there projects a triangular process[7] which articulates with inferior turbinated bone. The edges[4 5 6] articulate with the frontal, ethmoid, and superior maxillary bones.

Fig. 17.

INFERIOR TURBINATED BONE.

This is a porous scroll, placed at the inferior part of the nasal cavity below the ethmoid. Its posterior end is the more pointed. Its *internal surface* is convex and looks towards the nose; the *external surface* has a broad hook, *processus maxillaris*,[3] which enters the antrum Highmorianum, and partly closes it. The superior edge has a triangular process called *lachrymal*, which articulates with the unguis. The portions of the edge in front of and behind this process rest upon ridges of the nasal process of the superior maxillary and palate bones; there is frequently a process upon this edge which unites it with the ethmoid bone.

VOMER.

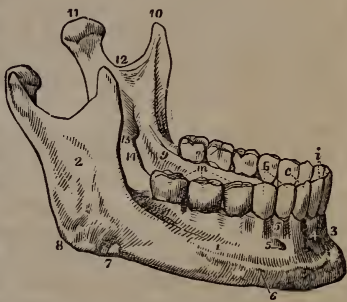
A single bone, forming a large portion of the nasal septum, consisting of two plates of compact structure. It is a flat bone with four edges. The superior is the thickest, having a deep groove between two lips (alæ) for the reception of the processus azygos of the sphenoid. The inferior edge is the longest, articulating with the nasal crista of the palate suture of the superior maxillary. The anterior unites with the nasal lamella of the ethmoid, and the posterior is thin, sharp, and concave, separating the posterior openings of the nose.

INFERIOR MAXILLARY.

Is also single, having a parabolic curve; placed at the inferior portion of the face. It consists of a body and two rami. The body is convex in front and presents in its middle the *anterior mental tubercle*[3] or spine, which in youthful life is a suture. On either side of this is a large hole, called the anterior mental[5] foramen, transmitting a part of the inferior alveolar artery and nerve. The portion of the bone between these two foramina is called the *chin*. The posterior surface of the chin is concave and has the posterior mental tubercle in its middle, upon which are two marks on each side, for the genio-hyoglossus and genio-hyoid muscles; on either side of this tubercle

or spine is a fossa for the insertion of the digastricus. Extending backwards from this tubercle, is a ridge[9] called mylohyoid, for the muscle of that name; above this ridge is a shallow fossa for the sublingual gland; below it and behind, is a larger one for the submaxillary gland. The *alveolar process* contains sockets for sixteen teeth. The inferior edge is the *base*, which is thicker in front, and has two corners giving a squareness to the chin.

Fig. 18.



The ramus[2] is square, and at right angles to the body in manhood; in youth and old age it is oblique; externally it is rough for the masseter muscle, anterior to which is a groove for the facial artery.[7] The internal face has a posterior mental foramen,[13] for the entrance of the inferior alveolar artery and nerve. To the edge of this foramen is attached the internal lateral ligament; near it is a groove[14] transmitting the mylohyoidean nerve; below, is the surface for the insertion of the internal pterygoid muscle. The angle[8] is rough, and has attached to it the stylo-maxillary ligament. The anterior edge of the ramus is continued into the external oblique ridge.[6]

The superior part of the ramus has two processes separated by[12] the sigmoid notch. The *coronoid* process is in front,[10] and is triangular and thin; it has inserted into its apex the temporal muscle; in front there is a groove for the buccinator muscle. The posterior is the *condyle*[11] articulating in the glenoid cavity of the temporal bone. The neck is narrow, and on the inside of it is a fossa for the insertion of the external pterygoid muscle.

OF THE HEAD IN GENERAL.

Sutures.—The principal sutures of the head are the *coronal*, which unites the parietal and frontal bones; the *saggital*, which unites the two parietal bones in the adult, and in a child extends to the root of the nose; the *occipital*, which joins the parietal and occipital bones; and the *squamous*, uniting the squamous part of the temporal and the parietal bones. Besides these there are others uniting the bones of the face. That part of the suture between the mastoid and parietal bones, is called *additamentum suturæ squamosæ;* and that suture between the mastoid and occipital, is called *additamentum suturæ occipitalis.*

Fontanels. — These are the deficiencies in ossification in the bones of the fœtal head. The *anterior* is large and quadrangular, situated

at the junction of the coronal and saggital sutures. The anterior angle is the most elongated. The *posterior* is small and triangular, and situated at the junction of the lambdoidal and saggital sutures. Besides these there are two smaller fontanels on either side; one is in the angle of the temporal, parietal, and occipital bones, and the other is at the junction of the temporal, parietal, and sphenoid bones.

Ossa Wormiana or *Triquetra* , are small bones, irregular in shape and number, sometimes found in the sutures, particularly about the middle of the lambdoidal. They have a distinct point of ossification.

The *diploe* is the cellular bony structure between the external and internal or vitreous tables; it is traversed by channels lined by a venous lining, which empty partly into the sinuses of the dura mater and partly into the emissaries of Santorini.

The *cavity of the cranium* is about six and a half inches in length, five in breadth and five in height. When the calvaria or arch of the cranium is removed, three deep fossæ are observed at the base on each side. The anterior is formed by the frontal, sphenoid, and ethmoid bones, and contains the anterior lobes of the brain; the middle is formed by the sphenoid and temporal bones, and lodges the middle lobes; the posterior is formed by the occipital and temporal bones, and contains the cerebellum.

Orbital cavity.—Is formed on each side by seven bones.

The cavity is conical, the apex being formed by the optic foramen; the base looks outwards and is somewhat quadrangular. The sphenoidal foramen or fissure opens into the orbit, and is also called *foramen lacerum superius;* another slit or fissure between the sphenoid and maxillary bones being the *foramen lacerum inferius.* Besides these there are other openings into the orbit already mentioned in the description of each bone.

Nasal Cavity.—This is an irregular cavity, separated from its fellow by the nasal septum. It has three distinct passages or *meatuses.* The *superior* is between the superior and middle turbinated bones, and has opening into it the posterior ethmoidal cells, the sphenoidal cells, and the spheno-palatine foramen. The *middle* is between the middle and inferior turbinated bones, and has opening into it the frontal sinus, anterior ethmoidal cells, and the antrum, usually. The *inferior* is the largest, and between the inferior turbinated bone and the floor of the cavity; into it opens the nasal duct. The opening into the nasal cavity in front is called the *anterior nares;* the opening behind *posterior nares.*

Zygomatic fossa, also called temporal, is the large fossa on either side of the head, formed by the parietal, sphenoid, temporal, and frontal bones, and bounded externally by the zygoma. The temporal muscle occupies nearly the whole fossa.

Pterygo-Maxillary Fossa or Fissure.—This is at the bottom of the zygomatic fossa, and formed by the sphenoid, palate, and superior maxillary bones. It is triangular, and the base is upwards. The

ganglion of Meckel is contained in it, which gives off branches going through the foramina which opens upon this fossa. It is continuous with the foramen lacerum inferius or spheno-maxillary slit.

Facial Angle.—This is formed by drawing a straight line from the lower part of the frontal bone to the anterior nasal spine, and intersecting it at this latter point by another drawn through the external meatus auditorius. It establishes a relation between the cranium and the face. The smaller the angle the more inferior is the conformation. By comparing the heads of the great races of the world, it is found to be 80° to 85° in Europeans, 75° in the copper-coloured or Mongolians, and 70° in Negroes.

In the African head these additional anatomical peculiarities will frequently be found. The temporal fossa is large, and the temporal ridges are more nearly approximated.

The pterygoid processes of the sphenoid project in a line parallel with the facial line and thereby alter the shape of the posterior nares.

The condyloid processes of the occiput are often divided into two portions by a ridge or groove.

The lower boundary of the anterior nares is deficient in a sharp ridge which characterizes the Caucasian head. In these peculiar features the African adult head seems permanently to retain marks which are generally found to belong to the fœtal head.

HYOID BONE.

This bone is situated in the neck and connected with the root of the tongue and upper part of the larynx. It is shaped like the Greek *v*, the convexity being in front. It does not articulate with any other bone. It consists of a body and four cornua. The *body*[1] is quadrilateral, convex in front, and concave behind. The front surface gives origin and insertion to muscles of the neck, and has a well-marked projection. The *greater cornua*[2] are about an inch in length, and in early life united to the body by means of cartilage and ligaments; they are flattened, project backwards, and terminate in a head or tubercle. They give origin and insertion to muscles of the neck. The *lesser cornua*,[3] are attached at the junction of the body and great cornua; they are cartilaginous usually, and of a few lines in length. To them are attached the stylo-hyoid ligaments.

Fig. 19.

UPPER EXTREMITY.

The upper extremity is divided into the shoulder, arm, forearm, and hand.

The shoulder consists of two bones, the scapula and the clavicle.

Scapula.—The shoulder blade of common language. Placed on the back part of the thorax between the second and seventh ribs. It is thin, flat, and triangular; has two surfaces, three edges, and three angles.

The *anterior face* is a concavity called *costa* or venter, divided by ridges, and giving origin to the subscapular muscle. The posterior face is the *dorsum*, divided by the spine into two fossæ; the fossa supra-spinata,[1] giving origin to the supra-spinatus muscle, and the fossa infra-spinata,[2] giving origin to the infra-spinatus muscle.

The spine[10] is a rough ridge running obliquely across the dorsum, and terminating in the acromion process. The edge of the spine gives origin to the deltoid, and insertion to the trapezius muscles; near the base of the scapula the spine has a small triangular surface,[11] over which plays the trapezius tendon. The acromion process is flat and triangular, has a small articular mark[12] in front for articulation with the clavicle.

Internal edge or base.—Is the longest, and nearly parallel [9] with the vertebral column; has an external lip for the insertion of the rhomboid muscles, and an internal one for the serratus anticus.

External edge. — Is thick,[5] and contains a *fossa* giving origin to the teres minor muscle. At the upper part of this fossa is a rough mark for the origin[8] of the long head of the triceps.

Fig. 20.

Superior edge.—Is thin and small,[3] and has a notch called coracoid,[4] which is converted into a foramen by a ligament, and transmits the supra-scapular artery and nerve. Near this notch arises the omo-hyoid muscle.

Superior angle.[15]—Almost a right angle, and has the levator anguli muscle inserted into it.

Inferior angle.—Is the most pointed,[7] and gives origin by its posterior surface to the teres major muscle, and is connected with the latissimus dorsi.

External angle.—Presents a large articular cavity,[6] called *glenoid*, upon a narrow neck. This cavity is oval and shallow; and at its summit is a mark showing the origin of the long head of the biceps muscle.

Coracoid process. — This projects forwards and outwards from the neck,[14] in a curved manner. Its tip has marks for the insertion of the pectoralis minor and also for the origin of the short head of the biceps

and coraco-brachialis. Its base has a tubercle to which is attached the conoid ligament.

CLAVICLE.

A long bone placed transversely at the upper and anterior part of the thorax, resembling in shape the italic *f*. It articulates with the sternum and scapula. The sternal two-thirds is convex anteriorly, and the humeral third concave anteriorly. The upper surface has a depression near the sternal extremity, showing the origin of the sterno-cleido-mastoid muscle. The inferior surface has a roughness near the sternal extremity for the rhomboid or costo-clavicular ligament, and near the humeral extremity a tubercle and ridge for the coraco-clavicular ligament; the space between these two marks is for the insertion of the subclavius muscle. The *anterior edge* gives origin by its sternal two-thirds to the pectoralis major, and by its humeral third to the deltoid. The *posterior* edge has a foramen for the nutritious artery.

The *sternal extremity* is thick and triangular, with a surface for articulation with the sternum; the posterior and inferior corner of it is elongated, which contributes to the strength of the articulation. The *humeral* extremity is flat and spongy, with an articular face for the acromion process of the scapula.

In the male the bone is shorter, thicker, and more curved than in the female.

HUMERUS.

The arm-bone is cylindrical, and reaches from the shoulder to the elbow. The superior extremity presents a hemispherical *head*[2] for articulation with the glenoid cavity of the scapula, separated by a deep groove, the *anatomical neck*,[3] from the shaft of the bone. Below this groove are two tuberosities; the *greater*,[4] is the external, and it has three facets for the insertion of the supra and infra-spinatus, and teres minor muscles; the *lesser*, on the inner side,[5] is for the insertion of the subscapularis. These tuberosities are separated from each other by a groove,[6] called *bicipital*, in which plays the tendon of the long head of the biceps muscle. The anterior or *external edge*[7] of this groove has the pectoralis major muscle inserted into it, and the posterior[8] or internal edge, receives the latissimus and teres major muscles. The *surgical neck* is between the insertion of these muscles and the anatomical neck of the humerus. About the middle of the shaft, and upon its outer side, is a triangular roughness[9] for the insertion of the deltoid; on the inner side and a little below is a ridge for the insertion of the coraco-brachialis:[10] below this ridge is the nutritious foramen, and above it is a shallow spiral groove for the musculo-spiral nerve and profunda major artery.

The inferior extremity is flat and broad; anteriorly it is covered by the brachialis anticus muscle, and posteriorly by the triceps. Exter-

Fig. 21.

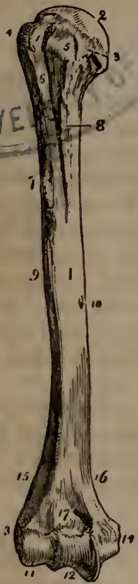
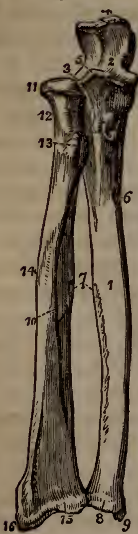


Fig. 22.



nally, there is a ridge[15] leading to the *external condyle*,[13] from which arise the supinator and extensor muscles. Internally a ridge[16] leads to the *internal condyle*,[14] which is more prominent than the external, and from which arise the flexor muscles of the forearm and the pronator radii teres.

The articular surface at the elbow consists of a hemispherical head[11] for the radius, and an irregular cylinder[12] for the ulna. Above this articular surface, and in front, is a fossa,[17] called the *lesser sigmoid cavity*, which receives the coronoid process of the ulna in extreme flexion; behind is a larger fossa, the *greater sigmoid*, for the olecranon in extreme extension. Sometimes these fossæ are connected by an opening.

ULNA.

The forearm consists of two bones—Radius and Ulna.

The Ulna is the longer, and is placed on the inner side, reaching from the elbow to the wrist.

The upper extremity is the larger, and has a hook-like process behind,[4] called *olecranon*, to which is inserted the triceps extensor cubiti. In front, is the *coronoid process*,[5] the base of which has a roughness for the insertion of the brachialis anticus muscle. Between the olecranon and coronoid processes, is the *greater sigmoid cavity*,[2] for articulation with the humerus: continuous with this is the *lesser sigmoid cavity*,[3] upon the outside of the coronoid process, for the articulation of the head of the radius. Behind the lesser sigmoid cavity, is a triangular, uneven surface, for the insertion of the anconeus muscle. This surface is limited by a ridge giving origin to the supinator radii brevis muscle.

The *body* is prismatic; the anterior surface[1] is occupied in its upper three-fourths by the flexor profundus, and in the lowest fourth, by the pronator quadratus muscle. The posterior surface is occupied by the extensors of the thumb and the indicator muscle.

The external edge[7] is the sharpest, and to it is attached the interosseous ligament.

The lower extremity has a small rounded head,[8] the outer side of which has a smooth articular surface for the radius. From the inner side, there

projects[9] the *styloid process*, to which is attached the internal lateral ligament; behind this process is a groove, in which glides the tendon of the extensor carpi ulnaris muscle.

RADIUS.

It is placed on the outer side of the ulna, and is slightly curved and prismatic.

The *superior extremity* has a rounded *head*,[11] the rim of which is smooth. The internal part plays in the lesser sigmoid cavity. The upper surface of the head has a cup-like depression for articulation with the humerus. Beneath the head is the *neck*,[12] the narrowest part of the bone. Below the neck, and on the inner side, is the *tubercle*,[13] rough below and smooth above, for the insertion of the biceps muscle.

The body is prismatic; *anteriorly*, the surface gradually increases in breadth,[10] giving origin to the flexor longus pollicis, and receiving the insertion of the pronator quadratus muscle. The *posterior surface* is occupied by the extensor major of the thumb and the indicator muscles. The *external surface* is curved, and has a roughness about the middle for the insertion of the pronator radii teres muscle, above which and below the tubercle is the space occupied by the insertion of the supinator radii brevis muscle.

The *inferior extremity* is thick and triangular. The articulating surface of the extremity[15] is concave and divided by a ridge. It articulates with the scaphoid and lunare. Continuous with this articular surface is a smaller one on the internal aspect of the extremity for the articulation of the ulna. Externally there is a *styloid process*,[16] for the attachment of the external lateral ligament.

Near a ridge which terminates in the styloid process, is inserted the supinator radii longus. Upon the dorsal view of this extremity of the bone, are three large grooves, each divided into smaller ones. The groove near the supinator ridge transmits the tendons of the extensor ossis metacarpi pollicis and the extensor minor pollicis; the groove in the middle is the broadest and most shallow, transmitting the tendons of the radial extensors; and the groove nearest the ulna transmits the tendons of the extensor communis, indicator, and extensor major pollicis. The portion of the groove occupied by the latter is very deep.

HAND.

The hand consists of the carpus, metacarpus, and digiti.

The CARPUS or wrist is oblong, the greatest diameter being transverse. The dorsal surface is convex, and the palmar surface is concave, with four prominences. This concavity transmits the flexor tendons.

It consists of *eight* bones arrayed in two rows. The bones of the

superior row are the *scaphoid*, *lunare*, *cuneiform*, and *pisiform*. Those of the *inferior* row are the *trapezium*, *trapezoides*, *magnum*, and *unciform*.

Scaphoid.—Is on the radial side, and resembles a boat; has a large convex surface superiorly for the radius, and inferiorly a deep concavity for the magnum. It articulates in front with the trapezium and trapezoides, and on the inside with the lunare.

Fig. 23.

Lunare.—Of a crescentic figure, has a convex surface superiorly for the radius, and a concavity in front for the magnum, articulates on the inside with the cuneiform.

Cuneiform.—Wedge-shaped, or pyramidal. Inferiorly it articulates with the unciform. Distinguished by a circular facet on its palmar surface for the pisiform.

Pisiform. — Pea-like bone, forms one of the prominences in the palm of the hand, has the flexor carpi ulnaris muscle inserted into it, and has but one articular mark, which is for the cuneiform. It is the smallest bone of the carpus.

Trapezium.—Has the most numerous surfaces and angles. The largest articular surface is for the thumb; two others, joining each other, are for the scaphoid and trapezoides. On the palmar surface is a ridge and a deep groove for the flexor carpi radialis tendon.

Trapezoides.—Is the smallest bone of this row. It is a four-sided pyramid with its apex towards the palm; its dorsal surface is the base and inclines inwards.

Magnum. — The largest bone of the wrist. Has a rounded head looking backwards; the body is quadrilateral.

Unciform. — Distinguished by a hook-like process, resembling a finger-nail, on its palmar surface: this gives origin to the flexor brevis minimi digiti.

METACARPUS.

Consists of five bones, each having a head, shaft, and base.

The *head* is rounded, articulating with the first phalanx; a roughness on each side indicates the attachment of the lateral ligament.

The *base* is the superior extremity, and is rough and quadrilateral, having articular marks on the extremity and either side.

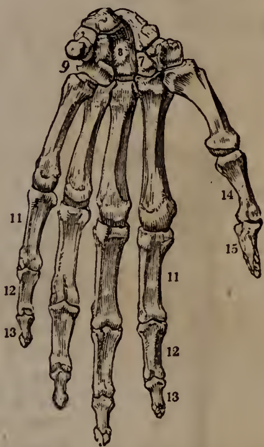
The *body* or *shaft* is prismoid, having impressions on its sides for the interossei muscles.

The *first* is short and thick, and belongs to the thumb. Its base

has but one articular surface, and that is for the trapezium. Its head is not very spherical, and its palmar surface articulates with the sesamoid bones.

The *second* is the longest, and belongs to the index finger; it has a *notch* at its base for articulating with the trapezoid; and a lateral articular mark upon one side only: a mark upon its dorsal surface indicates the insertion of the extensor carpi radialis longior.

Fig. 24.



The *third* has a *triangular* base with an articular mark on each side, and on its dorsum one for the extensor carpi radialis brevior.

The *fourth* is much smaller. The external lateral surface of its base is double.

The *fifth* is the smallest. Its base has but one lateral surface, and that is external and single. Internally there is a tubercle at the base for the extensor carpi ulnaris.

FINGERS.

The fingers contain three bones called *phalanges:* the thumb has but two.

First row.[11]—The *phalanges* of this row are the largest, convex on their dorsal, and flat on the palmar surface. The superior extremity has a single concavity for the head of the metacarpal bone. The inferior extremity has two convexities separated by a groove. A roughness on either side of this extremity, indicates the attachment of the lateral ligament. The ridges extending from one extremity to the other are for the theca of the flexor tendons.

Second row.[12]—These are smaller. The superior extremity has two concavities, separated by a ridge; the inferior two convexities, separated by a groove. The ridge on either side of the body has the theca and tendon of the flexor sublimis attached to it.

Third row.[13]—These are the smallest, and differ much from the other rows, having but one articular extremity, which is the superior, having two concavities and a ridge. The inferior extremity is flattened, thin, and rough.

The middle finger (*impudicus*) is the longest. The ring finger (*annularis*) is the next in size. The forefinger (*indicator*) is thicker than the last. The little finger (*auricularis*) is the smallest.

Sesamoid bones.—These are four in number—two being placed upon the palmar side of the lower extremity of the metacarpal bone of each thumb, imbedded with the short flexor tendon.

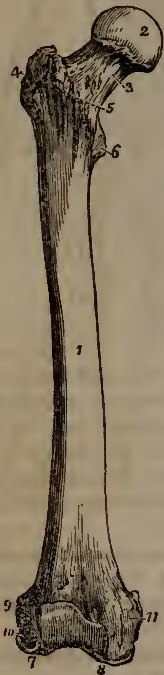
LOWER EXTREMITY.

FEMUR.

The *femur* is the longest bone in the body, reaching from the acetabulum to the knee.

The superior extremity presents a spherical *head*,[2] which has a depression upon it for the ligamentum teres. The part between the head and shaft is the *neck*,[3] which is shorter and more horizontal in old persons and in females. Externally is the *trochanter major*,[4] a large process having an oval mark in front for the gluteus minimus; and above a double mark for the gluteus medius; the tip has the pyriformis inserted into it, and behind the tip is the *digital fossa*, into which are inserted the gemelli and obturator muscles. Below and on the inner side is the *lesser trochanter*,[6] into which is inserted the psoas magnus, and iliacus internus muscles. A ridge between the trochanters behind, indicates the insertion of the quadratus femoris, and a corresponding one in front,[5] which is less distinct, serves for the connexion of the capsular ligament.

Fig. 25.



The *inferior extremity* is broader than the upper, and is divided by a fossa in front, and a notch behind, into two *condyles*. The *internal* condyle seems to be much the longer,[8] and is in reality somewhat so; its internal surface[11] gives origin to the internal lateral ligament and its posterior to the gastrocnemius muscle; its external surface assists in forming the notch, and has a roughness in front for the posterior crucial ligament.

The *external condyle*[9] contributes by its internal surface to form the notch, and has a roughness behind for the anterior crucial ligament. Its posterior surface gives origin to the popliteus, plantaris, and gastrocnemius muscles, and its external to the external lateral ligament.[10] The *fossa* in front, is unequally divided between the condyles, the larger and flatter portion belonging to the external. In this fossa plays the patella.

The shaft of the bone is curved *anteriorly*, and is covered in front by the origin of cruræus muscle. Posteriorly there is a rough ridge called *linea aspera* (Fig. 26), which consists of two lips having a tendency to separate above and below. The inner lip shows the insertion of the pectineus muscle,[p] of the adductor brevis,[ab] and of the adductor magnus [am] This last insertion occupies this inner lip in

nearly its whole length; so also does the origin of the vastus internus. The outer lip has inserted into it the gluteus maximus,[gm] and also gives origin to the vastus externus, and the short head of the biceps flexor cruris.[b]

Fig. 26.

PATELLA.

The patella is the largest sesamoid bone in the body, and commonly called the knee-pan. It is flat and triangular; thick and broad above, and thin and pointed below. The *anterior surface* is covered by integument; the *posterior* is a smooth articular surface divided by a ridge unequally—the external portion is the larger and flatter, adapted to a corresponding surface of the femur.

The *superior edge* is thick, and has the tendon of the rectus inserted into it. The inferior is pointed, and to it is attached the ligament of the patella.

TIBIA.

The tibia is longer and thicker than the fibula. It is placed on the inside of the leg, and commonly called the shin-bone. The superior extremity, or *head,* is large and thick, presenting an oval articular surface for articulating with the femur. This surface is divided by a pyramidal eminence, the *spinous process,*[4] into two surfaces, both of which are oval, but the internal is longer and deeper; to the base of this spinous process are attached anteriorly and posteriorly the *crucial ligaments;* in a depression upon its summit is fastened the posterior end of the external semilunar cartilage. (Fig. 27.)

An enlargement upon either side of the head are called tuberosities or condyles; upon the posterior part of the *external condyle*[3] is a small articular face, looking downwards, for the head of the fibula, upon the posterior part of the *internal condyle*[2] is a depression for the insertion of the semi-membranosus tendon.

Below the head, and in front, is a prominent *tubercle*[5] for the insertion of the ligament of the patella, and above it a smoothness corresponding with its bursa; below the head, and behind, is a triangular surface,[4] occupied by the poplitæus muscle, limited by an oblique ridge[5] (Fig. 28), which gives origin to the soleus muscle.

The *body* is prismatic. Its internal surface[6] (Fig. 27) is smooth and covered by the skin; the external surface[1] gives origin to the tibialis anticus and extensor communis digitorum; from the posterior surface arise the tibialis posticus and flexor communis digitorum.

The *anterior* edge[1] (Fig. 27) is sharp and superficial, generally curved with some resemblance to the italic *f*; the *external* has a ridge for thé attachment of the interosseous ligament, and the *in-*

Fig. 27.

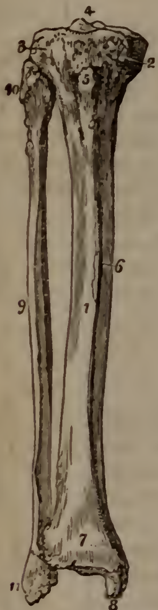


Fig. 28.

ternal is rounded, having the sartorius, gracilis, and semi-tendinosus inserted into it at its upper part.

The inferior extremity is smaller than the superior, and four-sided. Over the *anterior* surface pass the extensor tendons; on the *posterior* is a slight fossa[9] (Fig. 28) for the tendon of the flexor longus pollicis; *externally* there is a rough triangular fossa for the articulation of the fibula; and *internally* there is a large process, called the *internal malleolus*[8] (Fig. 28), behind which is an oblique fossa, transmitting the tendons of the tibialis posticus and flexor longus digitorum pedis. The inferior extremity of the malleolus is notched for the attachment of the internal lateral ligament; its internal surface is superficial; its external surface is continuous with the quadrangular concavity at the extremity of the bone, for the articulation of the astragalus.

FIBULA.

The fibula is a long thin bone placed upon the outside of the leg, and somewhat posteriorly at the upper part (Fig. 27[9], Fig. 28[10]). It

is slightly twisted in its appearance, and has a convexity backwards. The superior extremity or head is thick and large, and articulates with the external condyle of the tibia. External to this articular surface, is a mark for the attachment of the external lateral ligament of the knee-joint, terminated behind by a styloid process, for the insertion of the tendon of the biceps.

The body is prismatic, and has three surfaces; the external of which is the broadest, and commencing upon the anterior part of the bone above, winds around it, so as to terminate upon its posterior side below. The upper two-thirds of this surface give origin to the peroneus longus and brevis; the lower third terminates in a groove, which indicates the course of the tendons of these muscles. The internal face looks towards the tibia, and is divided longitudinally by a ridge, to which is attached the interosseous ligament; the space in front of which gives origin to the extensor proprius pollicis, and the extensor communis digitorum; and the space behind gives origin to the tibialis posticus. The posterior surface is also spiral, and gives origin to the soleus, and the flexor longus pollicis muscles.

The inferior extremity terminates in the *external malleolus*,[14] which is longer and flatter than the internal. Its external surface is superficial and triangular; its internal has a smooth articular surface for the astragalus. The extremity is pointed, and often called the coronoid process,[13] immediately within which is a rough depression for the external lateral ligament.

Fig. 29.

FOOT (Fig. 29).

It consists of the tarsus, metatarsus, and phalanges. The TARSUS consists of seven bones, viz.: os calcis, astragalus, cuboid, scaphoid, and three cuneiform.

Os Calcis.[3]—This is the largest of the tarsal bones, and constitutes the *heel*. Its figure is longitudinal. *Superiorly* it has two articular surfaces for the astragalus, separated by a deep groove, in which is fastened the interosseous ligament. The posterior portion is convex and the larger of the two. The anterior is narrow, concave, and divided by a small groove into two parts.

The *internal* surface has a deep concavity, called the sinuosity, for the passage of tendons, vessels, and nerves of the sole of the foot. The *external* surface is covered by the skin, and has two grooves for the tendons of the peroneous longus and brevis. The *inferior* surface has two tuberosities behind, of which the internal is the broader and larger; and also one in front. These tuberosities give origin to

muscles and ligaments. The *posterior* extremity[3] is rough and prominent in its inferior half, into which is inserted the tendo Achillis; the superior half is smooth, corresponding with the bursa. The *anterior* extremity presents two processes, called the greater and lesser apophyses; the *greater* is external and below, and has a flat triangular articular surface for the cuboid bone, surmounted by a rough projection. The *lesser apophysis* (sustentaculum tali) is a blunt hook projecting forwards and upwards, having an articular concavity above, constituting that portion of the superior surface of the bone, which articulates with the astragalus; upon its inferior surface is a groove for the tendon of the flexor longus pollicis.

Astragalus.[1]—Is next in size to the os calcis. It consists of a body and a head. *Superiorly* the *body* presents a large articular convexity for the tibia; continuous with this, on either side, is an articular surface for the malleoli; that upon the external side is the larger; *inferiorly* is a concavity, divided by a deep rough groove for the interosseous ligament; *posteriorly*, is a slight groove for the flexor longus pollicis.

The *head*[2] is upon the anterior portion of the bone. It presents a large anterior convexity, the horizontal diameter of which is the greatest. On the internal side of the head is a small triangular surface, which rests upon the calcaneo-scaphoid ligament. The head is united to the body by a narrow portion called the neck, which has a depression superiorly and inferiorly.

Scaphoid.[4]—Is oval, thicker above than it is below; *posteriorly* it has a deep concavity for the head of the astragalus; *anteriorly*, an articular convexity, divided by ridges into three triangular facets for the cuneiform bones. *Internally*, is a tubercle for the insertion of the tibialis posticus tendon; and *externally*, there is sometimes a small articular face for the cuboid.

Cuboid.[8]— Placed at the outer portion of the foot, is somewhat cuboidal in shape; *superiorly*, it is rough and convex; *inferiorly*, is a prominent ridge for the calcaneo-cuboid ligament, and in front of this ridge is a groove, commencing at the external edge, and running obliquely forward, in which plays the tendon of the peroneus longus; *internally*, it articulates with the external cuneiform; *anteriorly*, with the fourth and fifth metatarsal bones; *posteriorly*, is a semi-spiral surface for the greater apophysis of the os calcis.

Internal Cuneiform.[5]—Is the largest of the three cuneiform bones. It is wedge-shaped, and is placed upon the inner side of the foot. The small extremity of the wedge looks upwards. Its *internal* surface is convex, and immediately beneath the skin; its *external* surface is concave, and has articular marks for the second cuneiform and the second metatarsal bones; *anteriorly*, is the largest articular surface, for the metatarsal bone of the big toe; *posteriorly*, is a triangular articular cavity for the scaphoid, with the base downwards. The *inferior* surface of the bone, or the base of the wedge, is rounded into

a tuberosity; upon the inner side, is inserted the tendon of the tibialis anticus.

Middle Cuneiform.[6]—Is the *smallest* of the three, and placed with the base of the wedge upwards; *anteriorly*, it articulates with the second metatarsal bone; *posteriorly*, it is slightly concave, and articulates with the scaphoid; *internally*, it articulates with the internal cuneiform, and *externally*, with the external cuneiform bone.

External Cuneiform.[7]—Intermediate in size between the two last It is wedge-shaped and base upwards. *Anteriorly* it articulates with the third metatarsal bone; *posteriorly* there is a quadrangular facet for the scaphoid; *internally* it has two articular surfaces, the posterior of which is the larger, and for the internal cuneiform bone; the anterior is for the second metatarsal. *Externally*, there is an angular projection, in front of which is a small facet for the fourth metatarsal bone, and behind which is an articular surface for the cuboid bone.

METATARSUS.

Consists of five parallel long bones,[9] whose heads are rounded and articulate with the toes, and whose bases articulate with each of the three cuneiform and cuboid bones. There is a roughness on each side of the head to which is attached the lateral ligament. The necks are narrow.

First. Is on the inside of the foot, and is easily recognised, being the shortest and thickest of the set. Its base is large and articulates with the internal cuneiform bone, and has a tubercle below for the insertion of the peroneus longus. The head is spherical, articulating with the first phalanx in front, and below with the sesamoid bones.

Second. Is the longest. Its base articulates with the middle cuneiform, on the inside with the internal cuneiform, and on the outside with the third metatarsal and external cuneiform.

Third. Is distinguished by the external surface of its base having two articular facets for the fourth metatarsal. The base articulates with the external cuneiform.

Fourth. Its base articulates with the cuboid, and on either side with the contiguous metatarsal bone. The internal lateral face of the bone is distinguished by having two articular marks.

Fifth. Is the smallest and readily recognised by the large tubercle projecting backwards and outwards from the base, into the superior part of which is inserted the peroneus tertius, and into the extremity the peroneus brevis. This tubercle is a surgical guide in Hey's amputation of the foot. The base articulates with the cuboid and fourth metatarsal bones.

TOES.

There are five on each foot. Each consists of three *phalanges*, with the exception of the first or great toe, which, like the thumb, has but two.[10 11]

The *first row*[12] of phalanges are smaller than those of the fingers, and readily distinguished by the narrowness of their bodies. The bases have a single concavity; the anterior extremities have two convexities, separated by a groove.

The *second row*.[13]—These phalanges have hardly any body; the posterior extremities have two concavities separated by a ridge; and the anterior, two convexities separated by a groove.

The *third row*.[14]—These phalanges are very small; their bases have two concavities and a ridge. The anterior extremity is flat and rough.

Sesamoid Bones.—These are four small sections of a sphere of bone; two being imbedded in the tendon of the flexor brevis pollicis of each foot. The flat surfaces play on the inferior part of the head of the metatarsal bone of the great toe.

SECTION II.

ARTICULATIONS.

LIGAMENTS.

An articulation or joint is the connexion of one bone with another. Where much motion is required, it is necessary that *cartilage, ligaments,* and *synovial* membranes should be employed in the mechanism.

Cartilage.—Is white, flexible, elastic, and hard. Its chemical composition is, gelatine 44·5; water 55; phosphate of lime 0·5. By boiling it becomes yellow, swells, and the gelatine is dissolved. It resists mortification and putrefaction longer than any tissue except bone. When dried it becomes hard and contracted, and semi-transparent, resembling common glue. Soaking in water restores its appearance. It contains no blood-vessels, nor can nerves or lymphatics be traced in it. Microscopically examined it exhibits oval cells. Old age disposes it to ossify, particularly in the ribs and larynx.

Perichondrium is the fibrous investing membrane of cartilage, corresponding to the periosteum of bone.

Articular cartilages.—These cover the extremities of bone and obviate or equalize pressure. Those lining the cavity are thicker on the edges; those covering a convexity are thicker in the middle. *Inter-articular* cartilages are free and moveable in the joint, not covering a bony surface, and held in their places by connexion with ligaments: they are called menisci, from their shape.

Fibro-cartilage.—Is stronger and tougher than cartilage; it is composed partly of ligament and partly of cartilage; it is found in the ear, at the symphysis pubis, and between the vertebræ.

Ligaments consist of *fibrous* tissue, of which there are two kinds, *white*, which is inelastic, and *yellow*, which is elastic. The white is

found in tendons, fasciæ, and in most of the ligaments; the yellow is found in the ligamentum nuchæ, and in many vessels and ducts.

Ligaments are called *capsular* when they are bag-like, as at the shoulder and hip; *funicular*, when cord-like; and *membranous* when like a riband.

Synovial membranes are thin, transparent, closed serous sacs, lining capsular ligaments, and secreting an albuminous fluid called *synovia*, which resembles in appearance the white of an egg. It lubricates the joints, and prevents attrition. Masses of fat outside of the synovial membranes were formerly called *glands of Havers.* They do not secrete, however, but serve a mechanical purpose in filling up spaces which would otherwise be formed in many articulations during the performance of certain movements. The synovial fringes are nothing but folds of the synovial membrane, including small portions of fat.

The principal kinds of articulations are termed:

SYNARTHROSIS, implying immobility, and including

- *Sutura.*—Bones of the skull.
- *Harmonia.*—Superior maxillary bones.
- *Schindylesis.*—Vomer with processus azygos.
- *Gomphosis.*—Teeth with alveoli.

AMPHIARTHROSIS implies partial motion, and is exemplified in the symphyses, and in the bodies of vertebræ.

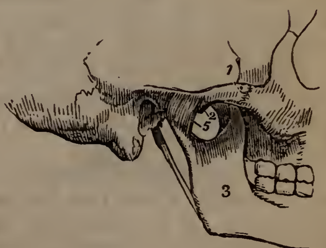
DIARTHROSIS is a moveable articulation, and includes

- *Arthrodia.*—Such connexions as exist between the tarsal and carpal bones.
- *Ginglymus.*—Hinge-like joints, such as the elbow and ankle.
- *Enarthrodia.*—Ball-and-socket joints, such as the hip and shoulder.

ARTICULATION OF THE LOWER JAW.

Capsular Ligament.—Extends from the border of the glenoid cavity of the temporal bone, and surrounds the neck of the condyloid process of the lower jaw.

Fig 30.



External Lateral Ligament.[5]—Is broad and triangular, covering the outside of the joint, extending from the tubercle at the root of the zygoma to the outside of the neck of the condyle. (Fig. 30.)

Internal Lateral Ligament.—Properly speaking, not a ligament but a fibrous band or sheath for the protection of vessels and nerves

from the contraction of the pterygoid muscles. It passes[4] from the spinous process of the sphenoid to the spine at the margin of the posterior mental foramen.[5] (Fig. 31.)

Stylo-Maxillary,[6] (Fig. 31,) is an extremely thin fibrous band, extending from the styloid process of the temporal bone to the angle of the lower jaw.

Fig. 31.

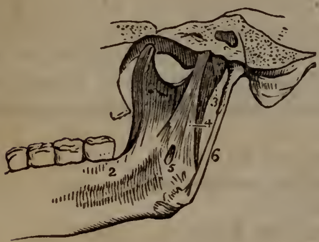


Fig. 32.

Internal Articular Cartilage[3] is a thin oval plate, dividing the joint into two cavities. It is partly concave above and below, thick at the edges. (Fig. 32.)

The Two Synovial Membranes.[4] [5] (Fig. 32.) One is reflected between the glenoid cavity and the interarticular cartilage; the other between the cartilage and the condyle of the jaw. When the cartilage[3] is perforate, the two cavities are lined by one synovial membrane.

LIGAMENTS OF THE VERTEBRÆ.

BODIES.

Intervertebral Substance.—The bodies of the vertebræ are united by fibro-cartilaginous disks, which are twenty-three in number, consisting of concentric rings; toward the centre there is a yellow jelly-like mass, in a state of compression; it is whiter and more abundant in infancy. On this account persons are stiffer in old age, and are shorter in the evening than they are in the morning.

Anterior Vertebral Ligament[1] is in front of the bodies of the vertebræ (Fig. 35[1]); extending from the second vertebræ of the neck to the first of the sacrum; it is thin and gradually increases in breadth.

Posterior Vertebral Ligament.—It lies upon the posterior surface of the bodies of the vertebræ, and extends from the occiput to the os coccygis; it is narrow and thick in the thorax, adheres closely to the intervertebral substance, and its edges present a serrated appearance.

PROCESSES. — *Oblique.* — These are surrounded by capsular ligament, lined by a synovial membrane.

Spinous. — The spaces between the processes are filled by the *inter-spinal ligaments.* In the back they are triangular, in the loins quadrangular, and in the neck deficient. The free edge of the ligament is thick and cord-like.

Ligamentum Nuchæ.—Continuation of the last, reaching from th seventh cervical vertebra to the vertical ridge on the occiput.

Yellow Ligaments are between the bony bridges of the vertebræ — twenty-three pairs; the first is between the second and third vertebræ. They are remarkable for their elasticity and colour.

ATLAS AND OCCIPUT.

Anterior Ligament, is a strong, broad ligament, extending from the superior edge of the anterior arch of the atlas to the basilar process of the occiput. The middle portion is thick, and connected with the tubercle of the atlas.

Posterior Ligament, is thin, broad, and loose, extending from the posterior arch of the atlas to the corresponding edge of the foramen magnum occipitis. It is perforated by the vertebral artery.

Capsular Ligament, surrounds the superior oblique process of the atlas and the condyloid process of the occiput. Thicker and stronger in front.

ATLAS AND DENTATA.

Transverse Ligament, stretches across the atlas from one tubercle to the other, dividing it into two rings[2] (Fig. 33). It has an appendix above,[3] connecting it with the occiput, and one below,[4] connecting it with the dentata.

Moderator Ligaments are short and thick; extending from the sides of the apex of the processus dentatus[5] to a process on the inner side of each condyle. They limit rotation of the head.

Fig. 33.

Middle or *Straight Ligament*,[3] reaches from the tip of the processus dentatus to the anterior edge of the foramen magnum.

Capsular Ligament of the oblique process of the atlas and dentata is very loose.

Lacerti Ligamentosi are ligamentous bands extending from the occiput to the posterior part of the body of the dentata.

LIGAMENTS OF THE PELVIS.

Sacro-Iliac Symphysis.—The articular surfaces are covered by car-

tilage and united by short, thick, strong fibres, which are with difficulty divided. A yellow fluid is sometimes interposed, and in children and pregnant women a synovial membrane.

Sacro-Iliac Ligament; short ligamentous fibres passing from bone to bone surrounding the joint, and thicker behind.

Fig. 34.

Sacro-Spinous Ligament; consists of two laminæ, composed of numerous strong fibres, passing from the posterior inferior spinous process to the transverse processes of the third and fourth sacral vertebræ.

Greater Sacro-Sciatic Ligament,[2] extends from the posterior inferior spinous process of the ilium, margin of the sacrum and of the first bone of the coccyx, to the inner margin of the tuberosity and ramus of the ischium.

Lesser Sacro-Sciatic Ligament; in front of last; arises from the side of the sacrum[3] (Fig. 34), and coccyx; inserted into the spine of the ischium.

These two ligaments form the posterior and lateral boundaries of the pelvis, converting the sacro-sciatic notch into two foramina[4 5] (Fig. 34).

Fig. 35.

Ilio-Lumbar Ligament, passes from the transverse process of the last lumbar vertebra to the posterior part of the crest of the ilium.[3] (Fig. 35.)

Lumbo-Sacral Ligament, arises from the transverse process of last lumbar vertebra, and is inserted into the upper part of the sacrum.[2] (Fig. 35.)

Anterior Coccygeal Ligament.—Its fibres are indistinct, often wanting; they run in front of the whole length of coccyx from the last bone of the sacrum.

Posterior Coccygeal Ligament, arises from the inferior margin of the sacral canal, and terminates at the second bone of the coccyx.

Obturator Ligament[5] (Fig. 35).—Fills up the thyroid foramen; is membranous and thin, perforated at its upper part for the transmission of the obturator vessels.

Sub-Pubic Ligament.—A thick, triangular ligament, rounding the apex of the arch of the pubis; reaching from one bone to the other.

Symphysis Pubis.—The bones are connected by fibro-cartilage, resembling intervertebral substance; in youth there is a synovial membrane. A few transverse fibres in front and behind are called anterior and posterior ligaments.

THORAX.

VERTEBRÆ WITH THE RIBS.

Anterior or Radiated Ligament. — Short fibres radiating from the head of the rib, to the two contiguous vertebræ and the substance between them.

Capsular Ligament. — Surrounds the head of the rib; thickest above and below.

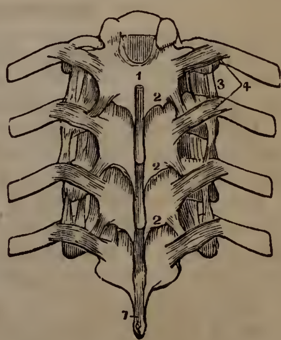
Inter-articular Ligament.—A thin band passing from the ridge on the head of a rib to the intervertebral substance, dividing the cavity into two parts, each of which has a distinct synovial membrane. The first, eleventh, and twelfth are exceptions to this rule.

The tubercle of the rib is connected to the transverse processes by a *capsular* ligament. The *internal costo-transverse ligament*[3] passes from the inferior edge of the transverse process, and is inserted in the sharp edge of the neck of the rib below.

External costo-transverse Ligament.[4] — Is quadrangular, extending between the transverse process and the contiguous rib.

Middle costo-transverse Ligament. — A collection of short irregular fibres mixed with reddish adipose tissue, passing directly from the transverse process to the rib.

Fig. 36.



RIBS WITH STERNUM.

Anterior extremity of ribs.

Anterior radiated Ligament[5] (Fig. 37).—Consists of a number of fibres, reaching from the cartilage of the true ribs to the sternum, and blending themselves with the periosteum.

Posterior radiated Ligament.—Not so distinct as the last, passing in the same direction upon the under surface.

Costo-xiphoid Ligament.—Reaches from the cartilages of the sixth and seventh ribs, to the ensiform cartilage.

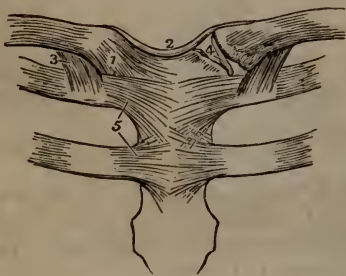
A synovial membrane and ligamentous fibres are found between the sixth and seventh, and eighth and ninth, sometimes.

UPPER EXTREMITY.

SHOULDER.

The clavicle and sternum have interposed a wedge-shaped *inter-articular cartilage*, dividing the joint into cavities, and the whole is surrounded by a strong *capsular ligament*[1] (Fig. 37), which is fibrous and thick, looser before than it is behind.

Fig. 37.



Inter-clavicular Ligament.[2]—A ligamentous cord stretching from the end of one clavicle to the other.

Rhomboid Ligament.[3]—A strong, thick ligament, proceeding from the upper surface of the cartilage of the first rib obliquely upwards and outwards to the inferior and sternal end of the clavicle.

CLAVICLE AND SCAPULA.

Capsular Ligament.[1]—Surrounds the acromion process of the scapula, and the external extremity of the clavicle. The fibres upon the upper and lower surface are very distinct and strong.

Coraco-clavicular Ligament[2] (Fig. 38).—Consists of two parts, one of which is called *conoid;* it is triangular and vertical; commencing at the root of the coracoid process, it expands as it ascends, and is fastened to the tubercle at the inferior extremity of the clavicle. The other is called *trapezoid;* it is in front of the last, arises at the internal edge of the coracoid process, and proceeds obliquely upwards to a ridge on the lower surface of the external end of the clavicle.

Bifid Ligament.—Is an aponeurotic expansion, commencing at the coracoid process, terminating upon the inferior surface of the clavicle, and also upon the cartilage of the first rib. It protects the inferior portion of the subclavius muscle.

Coraco-acromial Ligament[3] (Fig. 38).—Is thick and triangular; the base commences upon the outer edge of the coracoid process, and the apex is fastened to the acromion; it prevents a dislocation of the humerus upwards.

Coracoid Ligament[4] (Fig. 38).—Is a small transverse fasciculus, stretched across the coracoid notch, and converting it into a foramen for the supra-scapular artery and nerve.

HUMERUS AND SCAPULA.

Fig. 38.

Capsular Ligament[5] (Fig. 38).—Surrounds the glenoid cavity and the neck of the humerus. It is loose and perforated by the tendon of the long head of the biceps.[7] It is deficient behind; this deficiency is supplied by the tendons of the surrounding muscles, particularly the sub-scapularis.

Coraco-humeral Ligament.[6]—Is sometimes called *adscititium.* Is a thick fasciculus of the capsular ligament, proceeding from the coracoid process. It holds the head of the bone on a level with the glenoid cavity.

Glenoid Ligament.—A prismatic ring of fibro-cartilage, attached to the edge of the glenoid cavity, and increasing its depth. The synovial membrane is very extensive, and communicates with the bursæ of tendons in the vicinity.

ELBOW JOINT.

Capsular Ligament.—It surrounds the extremities of the humerus, radius, and ulna. It is strengthened by the

Internal lateral Ligament[2] (Fig. 39), which, commencing at the internal condyle, has two insertions, one into the coronoid, and the other into the olecranon process of the ulna.

External lateral Ligament[4] (Fig. 40).—Is triangular, commencing at the external condyle, and terminating in the annular ligament.

Coronary or annular Ligament[5] (Fig. 41).—Is strong and dense, surrounding three-fourths of the head of the radius; its extremities are fastened on either side of the lesser sigmoid cavity.

Interosseous Ligament[5] (Fig. 39).—Is a ligamentous membrane, filling up the space between the radius and ulna throughout their length. It is perforated at its upper part, for the transmission of the posterior interosseal artery; this deficiency is compensated for by the *ligamentum teres*[4] (Fig. 39), whose fibres are oblique and in an opposite direction to those of the interosseous ligament. It commences at the coronoid process, and terminates below the tubercle of the radius.

Sacciform Ligament.—Is a loose, capsular ligament, surrounding the lower extremity of the ulna, and attached to the lesser sigmoid cavity of the radius. This is strengthened by the *anterior radio-ulnar ligament*[2] (Fig. 42), which passes obliquely between the two bones, and by the *posterior radio-ulnar ligament.*

Fig. 39.

Fig. 40.

Fig. 41.

WRIST JOINT.

This joint is formed by the greater sigmoid cavity of the radius and by the scaphoid, semilunar, and cuneiform bones. It is surrounded by the capsular ligament, which is strengthened by an *anterior ligament*[3] (Fig. 42), a broad membranous layer; *an internal lateral ligament*,[5] reaching from the styloid process of the ulna to the cuneiform and pisiform bone; an *external lateral ligament*,[4] reaching from the styloid process of the radius to the scaphoid bone; and a *posterior ligament*,[6] which is thin and loose, passing between the posterior surface of the radius, semilunar, and cuneiform bones.

The *carpal* bones are held together by *dorsal* and *palmar* ligaments. The *pisiform bone* has a distinct *capsular ligament.* The arrangement of the synovial membrane is represented by[3] Fig. 43.

The bases of the *metacarpal bones* are secured to the second row of he carpal bones by fibrous bands called *dorsal* and *palmar* ligaments. That of the thumb has a true *capsular ligament.*

FINGER JOINTS.

The joint between the metacarpal bones and the first row of phalanges, is a ball-and-socket joint. It is secured by an *internal* and *external* lateral ligament[13] (Fig. 42), which are very thick in proportion to the size of the bone; the *anterior or palmar ligament*[12] is in front, and has the flexor tendons playing over it; the extensor

Fig. 42.

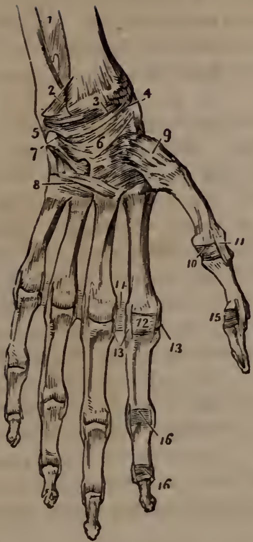
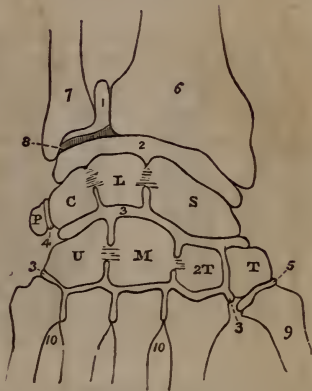


Fig. 43.



tendon taking the place of a *posterior ligament.* The heads of the metacarpal bones are also connected by transverse ligaments.[14]

The second and third joints of the finger[16] are arranged upon the same principle as the first, with the exception of the transverse ligament.

LOWER EXTREMITY.

HIP JOINT.

Capsular Ligament[8] (Fig. 35).—Is the largest and strongest capsule in the body, and surrounds the acetabulum and the neck of the femur. It is thicker and longer in front than it is behind, and is strengthened by a bundle of fibres,[9] called *ilio-femoral.*

Cotyloid Ligament[6] (Fig. 34).—Is a thick prismatic ring of fibrocartilage, surrounding and deepening the acetabulum.

Ligamentum teres[7] (Fig. 34).—Is attached to a pit upon the head of the femur, and divides into two fasciculi, which are inserted into the corners of the notch of the acetabulum and into the cotyloid ligament. The synovial membrane is extensive, and the Haversian mass is large.

KNEE JOINT.

This joint is surrounded by an expansion of the fascia lata of the thigh, called the *involucrum generale.*

Anterior Ligament.—Is the *ligament of the patella*[3] (Fig. 44); it is the strongest ligament of the body. It is a continuation of the tendon of the quadriceps muscle,[1] in which the patella[2] is enclosed, previous to its insertion into the tubercle of the tibia.

Fig. 44.

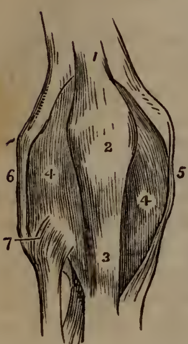
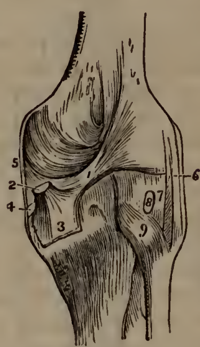


Fig. 45.



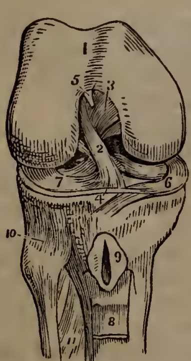
Posterior Ligament.—Is the *ligament of Winslow*[1] (Fig. 45). It is a broad ligament passing obliquely from the external condyle of the femur to the posterior part of of the internal tuberosity of the tibia. Its strongest fasciculi are derived from the semi-membranosus tendon.[2] It has numerous openings for blood-vessels.

Internal Lateral Ligament.—Is broad, thin, and membranous, extending from the internal condyle of the femur to the lower part of the internal tuberosity of the tibia.[5]

External Lateral Ligament.—Is a strong cord-like ligament[6] reaching from the external condyle to the superior extremity of the fibula. Posterior to this, and parallel with it, is another shorter ligament also connecting the femur and fibula.

Semilunar Cartilages.—Are two prismatic rings of fibro-cartilage, deepening the articular surfaces of the tibia. The external[7] (Fig. 46) is the smaller and more circular. The internal[6] is the larger and a semicircle. The extremities are attached to the spinous process of the tibia. A small transverse ligament[4] connects them behind.

Fig. 46.



Crucial Ligaments.—These cross each other. The *anterior*[2] (Fig. 46), arises from a roughness in front of the spine of the tibia, and is inserted into the posterior part of the internal face of the external condyle. The *posterior*[3] commences at a roughness behind the spine of the tibia, and is inserted at the anterior part of the external face of the internal condyle of the femur.

The synovial membrane is the most extensive in the skeleton; it forms folds in the interior of the joint, one of which is called the *ligamentum mucosum*,[5] which is triangular in shape, passing from the condyloid notch to a mass of fat in front of the tibia. The *alar ligaments* are

fringed folds of the synovial membrane, containing masses of fat on each side of the patella.

The tibia and fibula are connected above by the

Anterior Superior Ligament[7] (Fig. 44).—A short, strong ligament, extending obliquely between the heads of the two bones in front.

Posterior Superior Ligament[9] (Fig. 45).—Passes obliquely between he heads of the two bones behind. The synovial membrane of this articulation is generally distinct from that of the knee-joint.

Interosseous Ligament[11] (Fig. 46).—Is stretched between the tibia and fibula throughout their entire length, and an opening at its upper part transmits the anterior tibial artery.

Anterior Inferior Ligament (Fig. 48).—Is a broad band passing obliquely between the two bones in front, and at their lower extremity.

Posterior Inferior Ligament.—Is somewhat similar, passing obliquely between the lower extremities of the two bones. Besides these, the tibia and fibula are united by short strong fibres, passing from the contiguous surfaces of the two bones.

ANKLE JOINT.

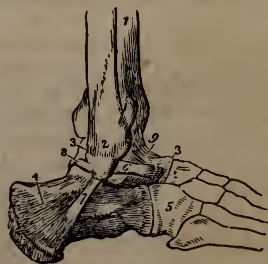
Is the most perfect hinge in the body.

Internal Lateral or *Deltoid Ligament*[6] (Fig. 47).—Is triangular; its apex is attached to the internal malleolus,[1] and its base to the os calcis, astragalus and calcaneo-scaphoid ligament. The tibialis posticus tendon runs in a trochlea upon it.

External Lateral Ligament[6 7 8] (Fig. 48).—Consists of three parts, which arise from the external malleolus;[2] the *anterior* passes forwards, and is inserted into the astragalus; the *middle* descends, and is inserted into the os calcis; the *posterior* passes backwards, and is fastened to the astragalus. The synovial membrane is large and loose, and is reflected upon some condensed cellular tissue in front, which is sometimes called the anterior ligament.

Fig. 47.

Fig. 48.



ARTICULATIONS OF THE FOOT.

The *astragalus* and *os calcis* are united by a strong, thick, interosseous ligament, passing from the groove on the upper surface of the os calcis to the corresponding one of the astragalus. — *Posteriorly* there is a short ligament, called the *posterior* ligament, upon which plays the tendon of the flexor longus pollicis muscle.

The *os calcis* and *scaphoid* are united by the *superior calcaneo-scaphoid* ligament, which passes from the inside of the greater apophysis of the os calcis to the outside of the scaphoid; and by the *inferior calcaneo-scaphoid,* which occupies the triangular interval between the lesser apophysis of the os calcis and the tubercle of the scaphoid. Upon this rests a portion of the head of the astragalus.

The *os calcis* and *cuboid* are united by the *superior* calcaneo-cuboid ligament, which is a very thin flat band of fibres extending directly forwards from the os calcis to the cuboid, and by the *inferior* calcaneo-cuboid, which consists of two planes of fibres, of which the superficial or inferior layer is a strong band of pearly-white fibres, extending from all the under surface of the os calcis to the groove of the cuboid. The deeper-seated or superior layer, extends from the anterior tuberosity of the os calcis obliquely to the ridge of the cuboid.

The *astragalus* and *scaphoid* are united by a thin semicircular ligament, consisting of parallel fibres, extending from the neck of the astragalus to the margin of the concavity of the scaphoid.

Cuneiform Bones.—They are united to each other and the scaphoid, by dorsal, plantar, and interosseal ligaments.

The Bases of the Metatarsal Bones.—That of the first is united by a strong capsular ligament with the internal cuneiform bone, having a distinct synovial membrane. Those of the second and third are united with the middle and external cuneiform bone, by dorsal and plantar ligaments; those of the fourth and fifth by dorsal and plantar ligaments with the cuboid.

The heads of the metatarsal bones are united to each other by a strong transverse ligament; and to the phalanges by two lateral, the plantar, and an expansion of the extensor tendon.

The phalanges. — Their ligaments are arranged similarly to those of the hand, and consist of *two lateral* and *one plantar.*

TEETH.

The teeth are placed in the alveolar processes of the upper and lower jaw, and are the hardest portion of the human body. The permanent teeth are thirty-two in number, sixteen in each jaw; they are divisible into four classes. On each side of each jaw there are two *incisors,* one *cuspid,* two *bi-cuspid,* and three *molars.* Each tooth consists of a body or crown, which is the part exposed above the gum; the neck, a narrow portion surrounded by the gum, and a root or fang which is contained within the alveolus. The roots are surrounded by

a periosteum, and perforated at their extremities by a foramen for the transmission of an artery and nerve.

Incisors.—Are next to the median line; their edge is bevelled, and in early life serrated; the root is single and conoidal; those of the upper jaw are larger than those of the lower jaw.

Cuspid, or *Canine.*—These are next to the incisors. They have conoidal bodies, and their roots are the longest Those of the upper jaw are sometimes called eye-teeth, those of the lower jaw stomach-teeth.

Bi-cuspids.—Are next in size to the molars. The body has two grinding points, of which the external is the larger. The root is sometimes bifid and grooved upon either side. The anterior is the smaller.

Molars.—They have large quadrilateral bodies, with four or five grinding points. In the upper jaw they have three diverging roots, two of which are external, and one is internal. In the lower jaw they have but two roots, which are anterior and posterior. The third molar or wisdom-tooth is smaller, and less perfectly developed than the other two, and does not appear until manhood.

Fig. 49.

Structure.—Each tooth has three textures, the *ivory* or *dentine*, the *enamel*, and the *cementum*.

The *ivory* forms the largest portion of the body, neck, and root, and gives form to the tooth. It is of a dull white colour, and harder than bone. Although apparently very compact, nevertheless it consists of numerous fine tubes (*dental tubuli*), the average diameter of which is about $\frac{1}{4500}$th of an inch. These tubes are larger at their commencement, which opens upon the pulp-cavity. They radiate in nearly parallel lines, and their finest ramifications sometimes terminate in minute cells or in loops. The tubular character is proven by the passage of ink and other fluids along them. The intertubular substance is translucent, and finely granular.

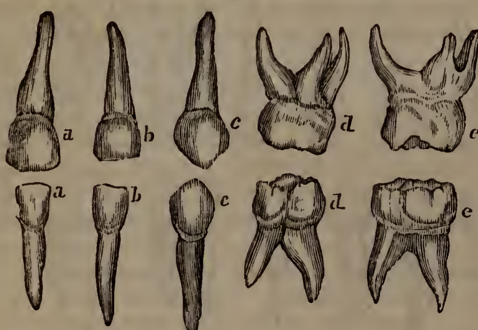
Dentine consists of 28 parts of animal, and 72 parts of earthy matter. The principal components are gelatine and phosphate of lime. It contains neither blood vessels nor nerves.

The *enamel* is the hardest portion; it encrusts the body; it is white, brittle, and semi-transparent, thicker upon the grinding surface, and terminates by a thin edge at the neck. Its structure consists of radiating hexagonal prisms of about $\frac{1}{500}$th of an inch in diameter: it possesses neither vessels nor nerves. It is composed of earthy matter almost entirely; so that the action of an acid leaves but a trace of the animal matter.

The *cementum* or crusta petrosa forms a thin coating over the root of the tooth, from the apex to the enamel. It resembles bone in structure, containing cells and canaliculi. It increases with the advance in age, making the teeth of old persons appear to project.

A *cavity* exists in the body and fangs of the teeth, which is filled by a *pulp*, which is principally composed of an artery, vein, and nerve, which enter at the small orifice at the point. The pulp-cavity diminishes in adult life by the formation of cementum in its upper part, which prevents the exposure of the pulp even when the body is much worn away.

Fig. 50.



An infant gum contains the rudiments of fifty-two teeth, in separate cavities; twenty of them appear between the sixth month and third year of age, and fall out between the sixth and twelfth year; they are therefore called the *deciduous* or milk teeth, of which there are *two incisors*,[a, b] *one cuspid*,[c] and *two molars*,[d, e] on either side of each jaw. The order of the irruption is irregular, but the average is as follows: at the seventh month, two middle incisors; ninth month, two lateral; twelfth month, first molar; eighteenth month, canine; twenty-fourth, two last molars. The teeth of the lower jaw precede those of the upper by a short interval. The original state of the tooth is a soft pulp contained in a sac, which pulp gradually becomes converted into dentine. The enamel is formed in the outer wall of the sac. The

cementum is formed by the periosteum of the tooth, which is the remains of the old sac.

INTEGUMENTS, ETC.

CELLULAR TISSUE.

The cellular or areolar tissue is that substance found so universally distributed throughout the body. It serves for the purpose of connecting muscles and other organs, and also forms a protection against pressure, being particularly abundant beneath the skin. When parts are torn in a subject it is very distinct, and its characters can then be best observed. It will be found to be white in colour usually, and to consist of a number of cells or areolæ which frequently communicate, as is manifested in anasarca, emphysema, and ecchymosis. It is elastic and tough when fresh; when dried it is opaque and crisp; long boiling converts most of it into gelatine. Its *toughness* is due to one set of fibres, which are white, inelastic, and straight; of such most ligaments are formed. Its *elasticity* is due to another set of fibres, which are yellow, elastic, and curling; of such the ligamentum nuchæ and middle coat of arteries are composed.

It is very vascular, though most of its vessels do not contain red blood in health, as may be seen in inflammation produced by the air or any other stimulus. Its moisture is due to serum.

FAT.

Fat is found in almost every part of the body, with the exception of the penis, ear, eyelid, and ball, interior of cranium, lungs, &c., &c., but in great abundance under the skin and around the serous membranes. It is of a yellowish colour, and in life is in a semi-fluid condition. It consists of three elements, stearine, margarine, and elaine, which are contained in vesicles aggregated in lobules, held together by areolar tissue. In women fat is more abundant; and in infants it is upon the surface of the body, rather than in the cavities.

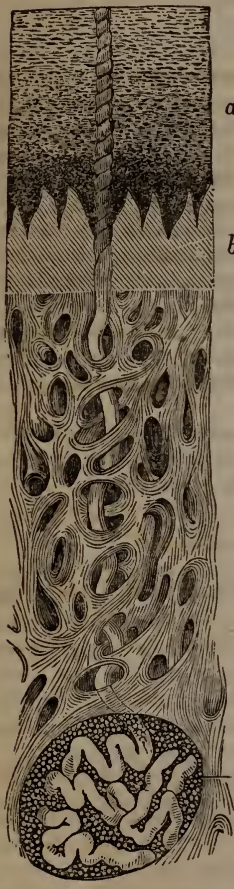
It is of use in diminishing pressure upon the hands and feet; retains heat, being a bad conductor, and assists in nutrition, as is manifested in hibernating animals.

SKIN.

The skin is an external covering and protection, as well as an organ of touch and excretion. Its colour and thickness vary in different persons and in different parts of the same person. At the orifices of cavities it is converted into mucous membranes. The largest *wrinkles* are produced by the contractions of muscles, and by the flexion of joints; others of an angular variety, owing to the contractile character of the skin, are seen upon the back of the hand; the third variety is spiral.

The skin is perforated by hairs and perspiratory ducts, and contains sebaceous glands; these are considered as *appendages*. The skin consists of two layers, the true skin, also called cutis vera or chorion, and the cuticle or epidermis.

Fig. 51.



The *cutis vera*[c] is the thicker and deeper of the two: it is white, and semi-transparent in all persons; its internal or inferior surface is much blended with the subjacent cellular tissue, and contains a number of pits or depressions. The external surface has a number of conical projections called *papillæ tactus*,[b] which are particularly numerous in those parts where there is much motion. On the hands and feet they are arranged in spiral and semicircular rows, which occasion a similar wrinkle of the cuticle. They consist of an artery, vein and nerve; the sensibility of a part is in ratio to their number. The skin itself is formed of condensed cellular tissue, the yellow fibrous element predominating where great elasticity is required, as in the armpit; the white element, where resistance is demanded, as in the sole of the foot. Between the interstices of these fibres pass innumerable vessels, ducts, &c., &c. It is thickened by pressure; boiling reduces it to gelatine; and tannin converts it into leather.

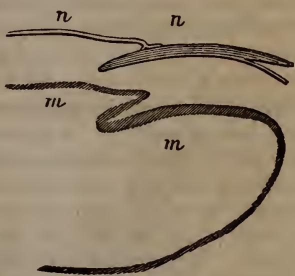
The *cuticle* or *epidermis*[a] affords protection to parts most exposed to pressure or friction; its thickness varies with the amount of pressure to which it is subjected, as is seen by the comparison of the hand of the artisan with that of a delicate female. It is not permeated by vessels or nerves, but consists of particles arranged in different laminæ; those that are deepest are granular, those of the next layer are more compressed, whilst those upon the surface are mere scales. These superficial scales, which are horny, are constantly being shed, and new particles constantly supplied by the moist granules, which are below. The laminated condition makes it easy to divide into different layers, and the inferior layer was formerly called by a distinct name, *rete mucosum;* but it is

nothing more than the deepest or most recently-formed part of the cuticle, in which are cells containing the colouring matter: this is very abundant in moles, freckles, and in the skin of negroes.

NAILS.

The *nails* are modifications of the epidermis. Their appearance is too familiar to every one to demand description. That portion which is concealed is called the *root;* that which is free or projecting, the *edge;* that attached to the surface of the cutis is the *body.* The *matrix* is that portion of the cutis under the root and body, which produces the nail. The *lunula* is that crescentic, white portion of the matrix near the root, and is due to a different arrangement of the capillaries in that part of the matrix. The nail firmly adheres to the matrix, and is moulded upon it like the epidermis in other situations. The epidermis or cuticle is *continuous* with the nail, and neither passes over or under it; being essentially of the same structure. By maceration the epidermis and nail [n n] can readily be removed from the *cutis vera.* [m m] The border of the root of the nail is jagged, thin, and soft, and consists of newly-formed substance; the deep surface of the body is also soft, and marked by longitudinal grooves corresponding to the papillary ridges on the surface of the matrix; but the edge and superficial portion of the nail is composed of scales more dense and fibrous.

Fig. 52.



HAIRS.

Hairs are found on all parts of the surface, except the palms of the hands, and soles of the feet; and vary in length, thickness, shape, and colour, according to situation, age, sex, or race. The *shaft* is that portion projecting beyond the surface; the *bulb* is that extremity contained in a follicle of the skin. The cuticular lining of this follicle is continuous with the bulb itself, there being a gradual change in the scales, as they pass from the follicle into the hair-bulb; the hair itself grows from the bottom of the follicle, like the nail from the matrix, or the epidermis from the cutis. If the hair is to be coloured, pigment-granules are here also developed.

The *human* hair is a *rod,* and not as commonly supposed, a *tube.* The scales in the axis of the hair are softer, and not so closely condensed as those of the surface, and thus they contain a larger amount of pigment in the interstices, which produces that dark appearance

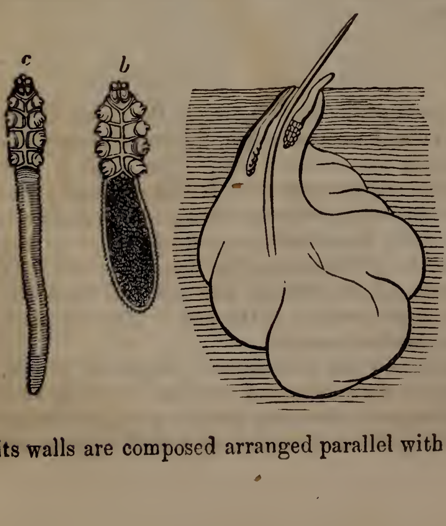
which is mistaken for a tube; this loose, porous structure in the middle, is sometimes called the *medulla*, and the condensed, fibrous exterior is termed the *cortex*. The scales of the cortex are imbricated, overlapping each other like the shingles of a roof. Where the hairs are large, and especially where they serve as tactile organs, there may be a papilla in the bottom of the follicle furnished with nerves and vessels, which projects into the bulb, as in the whiskers of a cat, and the quills of a porcupine; an approach to this papillary projection may be seen in some of the hairs of man, but their size is much overrated.

The hairs maintain a vital, though not a vascular connexion with the body; the moisture is partly due to the sebaceous glands, whose secretion passes through them by capillary attraction. Mental emotion has occasioned the hair to become white in a single night; some account for this by a secretion of fluid acid which percolates the tissue of the hair, and chemically destroys the colour. Ordinary gray hair resembles other hair in every respect, save that of colour.

SWEAT GLANDS.

These are found in great number upon the inferior surface of the *cutis vera* generally. In the axilla they form a layer, an eighth of an inch thick, which is mammilated, and of a reddish colour. They are about the size of a pin's head, are soft, and often compressed and surrounded by a network of capillary blood-vessels. They are distinguishable from pellets of fat by their pink colour, and semi-transparent texture. When magnified, they are seen to consist of a solitary tube, intricately ravelled, one end of which is closed, and buried within the gland,[d] and the other (Fig. 51), opens upon the skin. As it passes through the under layer of the cuticle, its parietes are not well defined. The duct consists of two portions: the *dermic* part winds tortuously through the true skin, and terminates in a funnel-shaped opening between the papillæ tactus; the *epidermic* portion commences at the lower part of the cuticle, at first very indistinctly and without any defined continuity of structure with the duct below, gradually assuming the spiral form, and having the scales of which its walls are composed arranged parallel with the axis of the passage.—

Fig. 53.



The secretion varies in odour in different portions of the body and in different races.

SEBACEOUS GLANDS.

The *sebaceous glands* are found in most parts of the skin, except in the palms and soles; they are most abundant on the scalp and face, especially about the nose. The orifices open into hair follicles, or upon the general surface. (Fig. 54.) They consist of a duct, terminating in a blind, pouch-like extremity, lined by an epithelium, in the particles of which are included granules of sebaceous matter. The secretion is subservient for the lubrication of the hair and the skin. There are generally found in their ducts, parasites, of which two specimens are given in *b* and *c*, Fig. 53. These animals are found in almost every

Fig. 54.

individual, especially in those possessing a torpid skin; and they multiply in sickness.

The ceruminous glands of the ear resemble the sebaceous glands in structure.

SECTION III.

MUSCLES.

Muscles are formed of that substance usually called *flesh*, which has a peculiar contractile power, producing motion; they consist, independently of the cellular tissue, vessels, and nerves, which enter into

their formation, of a special tissue. Those muscles which are excited by the will, such as those of locomotion, are called *voluntary.* Those which act independently of the will, such as those of the intestines and uterus, are called *involuntary. Voluntary muscle* is composed of a number of bundles of fibres, called fasciculi or lacerti.

The fibres are about $\frac{1}{400}$th of an inch in diameter, and are crossed by regular transverse striæ, which give rise to the term "striped," as applied to the voluntary muscles; although there are some striped muscular fibres found in organs which are involuntary, as in the case of the heart, pharynx, and upper part of œsophagus.

Each fibre consists of a number of filaments or fibrillæ, included in a tubular sheath, formed of a tough, delicate, elastic membrane, called the sarcolemma. Each fibrilla consists of a number of quadrangular particles, arranged in a linear series, and called *sarcous elements.*

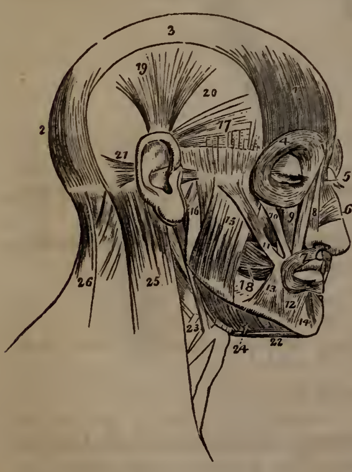
The blood-vessels pass in between the fasciculi, and terminate in a capillary network, which passes between the fibrillæ.

The nerves also penetrate the fasciculi, and terminate in loops, which do not penetrate the sarcolemma of the fibres.

Involuntary muscles consist of pale "unstriped" fibres, with the exception of the heart and gullet. They are generally flattened, and it is doubtful whether they have a sarcolemma. They are much smaller than the striped fibres, being not more than $\frac{1}{2500}$th part of an inch in diameter. The chief constituent of muscle is fibrin.

The red colour of muscles is not altogether dependent upon the capillary vessels, but upon a peculiarity of colouring matter united with them.

Fig. 55.



Every muscle has a belly and two extremities; that which is fixed is called the *origin* or *head;* that which is moveable, the *insertion.* Those which surround orifices, are called *sphincters.*

A *tendon* is formed of condensed white fibrous tissue, reaching from the end of a muscle to some structure which it is intended to move.

For further description, see "Physiology."

MUSCLES OF THE HEAD AND NECK.

Occipito-frontalis.[1,2,3]—Has four bellies.

Origin, from the superior semicircular ridges of the occiput.

Insertion, into the superior margin of the orbicularis oculi, and corrugator supercilii, and into the internal angular process of the os frontis and os nasi. *Use;* it elevates the eyebrows, making transverse wrinkles.

Compressor Naris.[6]—*Origin*, from the root of the ala nasi. *Insertion*, tendinously into its fellow on the dorsum of the nose, and into the lower part of the os nasi. *Use;* it either compresses or dilates the nostril.

Orbicularis palpebrarum.[4]—This is a sphincter surrounding the orbits of the eyes. *Origin*, from the nasal process of the superior maxillary, the os unguis, the internal angular process of the os frontis, and the internal palpebral ligament. *Insertion*, into the orbital and nasal processes of the superior maxillary, and into the palpebral ligament. *Use;* it closes the eyes.

That portion of the muscle immediately covering the eyelids is called *ciliaris*.

Corrugator supercilii.—A narrow, small, and pointed muscle, beneath the occipito-frontalis. *Origin:* internal angular process of the os frontis.—*Insertion*, into the occipito-frontalis and orbicularis. *Use;* it makes vertical wrinkles of the forehead.

Levator Labii superioris alæque Nasi.[8]—It lies on the side of the nose. *Origin*, from the nasal and orbitar processes of the superior maxillary bone. *Insertion*, into the upper lip and wing of the nose. *Use;* it elevates the wing and sides of the nose.

Levator anguli Oris.[9]—Small and concealed by the last. *Origin*, from the superior maxillary bone, below the infra orbitar foramen. *Insertion:* corner of the mouth. *Use;* elevates the angle of the mouth.

Zygomaticus minor.[10]—*Origin*, from the malar bone. *Insertion*, into the upper lip. *Use;* it raises the upper lip outwardly.

Zygomaticus major.[11]—*Origin*, from the malar bone, behind the last. *Insertion*, into the corner of the mouth. *Use;* it draws the mouth obliquely upwards and outwards.

Depressor Labii superioris alæque Nasi.—Very much concealed. *Origin*, from the alveolar processes of the incisor and canine teeth. *Insertion*, into the wing of the nose and upper lip. *Use;* depresses the upper lip and wing of the nose.

Depressor anguli Oris.[13]—*Origin*, from the base of the lower jaw, on the side of the chin. *Insertion*, into the corner of the mouth. *Use;* it draws the mouth downwards.

Depressor Labii Inferioris.[12]—*Origin*, from the base of the lower jaw, beneath and in front of the last. *Insertion*, into the whole side of the lower lip. *Use;* it draws the lip downwards.

Levator Menti.[14]—Is much concealed, and best viewed from the inside of the lip. *Origin*, from the alveolar processes of the lateral incisor and canine teeth. *Insertion*, into the lower lip. *Use;* it elevates the lip.

Buccinator.[18]—*Origin*, from the coronoid process of the lower jaw,

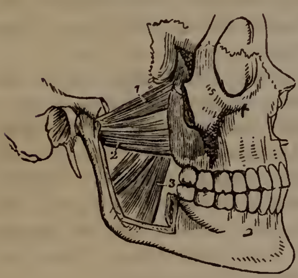
from the tuber of the upper jaw, and alveolar processes of both jaws. *Insertion*, corner of the mouth and lips. *Use;* it draws the mouth backwards, and presses the food between the teeth.

Orbicularis oris.[7]—Is a circular muscle surrounding the mouth, has neither bony origin nor insertion, but is much connected with other muscles of the mouth.

Masseter.[15 16]—*Origin*, from the superior maxillary and malar bones, and also from the zygoma of the temporal bone. *Insertion*, into the angle and external surface of the lower jaw. *Use;* it draws the jaw upwards and backwards. It is very strong, and consists of two planes of fibres.

Temporalis.—*Origin*, from the temporal fascia, and sides of the temporal, frontal, and parietal bones. A few fibres also arise from the zygoma. *Insertion*, into the coronoid process of the lower jaw. *Use;* it draws the jaw upwards.

Fig. 56.



Pterygoideus externus.[1]—*Origin*, from the pterygoid, spinous and temporal processes of the sphenoid, and from the tuber of the upper maxillary bone. *Insertion*,[2] into the neck of the lower jaw. *Use;* it draws the jaw forwards.

Pterygoideus internus.[3]—*Origin*, from the internal pterygoid process, and pterygoid fossa of the sphenoid; and from the Eustachian tube. *Insertion*, into the internal surface of the angle of the jaw. *Use;* it draws the jaw upwards and inwards.

MUSCLES OF THE NECK.

Fasciæ.—There are two fasciæ for the neck; the superficial and deep.

The *superficial fascia* is continuous with that which covers the whole body. It consists of two laminæ, between which are enclosed the platysma myoides muscle.

The *deep fascia* is formed of more condensed cellular tissue, and extends from the ligamentum nuchæ to the larynx in front, including between its laminæ vessels of the neck. Below it is fastened to the sternum, clavicles, and first ribs. A strong process of it exists between the styloid process of the temporal bone and the angle of the jaw, and is called the stylo-maxillary ligament. It forms a loop, which acts as a pulley to the omo-hyoid muscle, and thence is continued down behind the subclavius muscle into the ligamentum bicorne, forming a portion of the boundary of the thorax.

Platysma myoides.—This is included between two laminæ of the

superficial fascia of the neck, is a broad, thin muscle, and not always well developed in man. *Origin*, from the condensed cellular tissue below the clavicle. *Insertion*, into the muscles and integuments upon the side of the face and lower jaw. *Use;* it draws the skin of the neck and lower jaw downwards.

Fig. 57.

Sterno-cleido-mastoideus,[11] forms the most prominent feature on the outside of the neck. *Origin*, from the upper part of the sternum,[12] and sternal end of the clavicle.[13] *Insertion*, into the mastoid process of the temporal and into the superior semicircular ridge of the occipital bone. *Use;* acting with its fellow, it draws the chin towards the breast.

Sterno-hyoideus.[14]—*Origin*, from the sternum, clavicle, and cartilage of the first rib. *Insertion*, into the inferior edge of the os hyoides. *Use;* it draws the hyoid bone towards the sternum.

Sterno-thyroideus.[15]—*Origin*, from the sternum and cartilage of the first rib. *Insertion*, into the side of the thyroid cartilage. *Use;* it draws the cartilage downwards.

Thyreo-hyoideus.[16]—*Origin*, from the side of the thyroid cartilage. *Insertion*, into the body and cornua of the os hyoides. *Use;* it approximates the hyoid bone and thyroid cartilage.

Omo-hyoideus.[17] [18]—*Origin*, from the superior edge of the scapula, near the coracoid notch. *Insertion*, into the base of the hyoid bone. *Use;* it draws the hyoid bone downwards. It is tendinous in its middle.

Digastricus.[1] [2]—*Origin*, from the fossa, behind the mastoid process of the temporal bone. *Insertion*, into the base of the lower jaw, at the side of the posterior mental tubercle; its middle is tendinous, and perforates the stylo-hyoid muscle near its insertion. *Use;* it elevates the hyoid bone, and opens the mouth, even when the lower jaw is fixed.

Stylo-hyoideus.[3] [4]—*Origin*, from the middle and inferior part of the styloid processes of the temporal bone: it is perforated by the digastricus. *Insertion*, into the junction of the body and cornua of

the hyoid bone. *Use;* it draws the hyoid bone upwards and backwards.

Stylo-glossus.[9]—*Origin,* from the upper and internal part of the styloid process. *Insertion,* into the side of the root of the tongue. *Use;* it draws the tongue backwards.

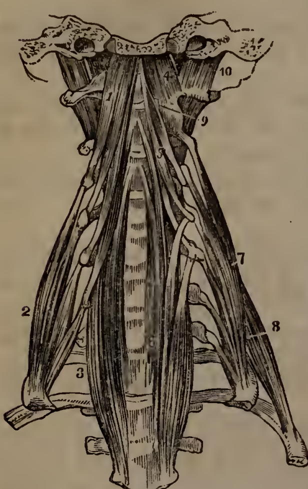
Stylo-pharyngeus.[10]—*Origin,* from the inner side of the styloid process near its root. *Insertion,* into the side of the pharynx, between the superior and middle constrictor muscles. *Use;* it raises and widens the pharynx.

Mylo-hyoideus,[5] forms the floor of the mouth. *Origin,* from the mylo-hyoidean ridge of the inside of the lower jaw. *Insertion,* into a white tendinous line, between it and its fellow, and into the hyoid bone. *Use;* it draws the hyoid bone upwards, and projects the tongue.

Genio-hyoideus.[6]—*Origin,* from the posterior tubercle, inside of the chin. *Insertion,* into the body of the hyoid bone. *Use;* it draws it upwards and forwards.

Longus-colli.[3 5 6]—*Origin,* from the bodies of the three superior dorsal vertebræ, and the transverse processes of the five lower cervical. *Insertion,* into the bodies of all the cervical vertebræ. *Use;* it bends the neck forwards and to one side. (Fig. 58.)

Fig. 58.



Rectus capitis, anticus major.[1]—(See Fig. 58.) *Origin,* from the transverse processes of the third, fourth, and fifth cervical vertebræ. *Insertion,* into the basilar or cuneiform process of the occiput. *Use;* it bends the head forwards.

Rectus capitis anticus minor.[4]—*Origin,* from the atlas near its transverse process. *Insertion,* into the basilar process of the occiput. *Use;* it bends the head forwards.

Rectus capitis lateralis.[10]—*Origin,* from the transverse process of the atlas. *Insertion,* between the condyle and jugular eminence of the occipital bone. *Use;* it draws the head to one side.

Scalenus anticus.[2]—*Origin,* from the transverse processes of the fourth, fifth, and sixth cervical vertebræ, tendinously. *Insertion,* into the upper surface of the first rib in front of the groove for the subclavian artery. *Use;* it bends the neck forwards, or raises the first rib.

Scalenus medius.[7]—*Origin,* from the transverse processes of all

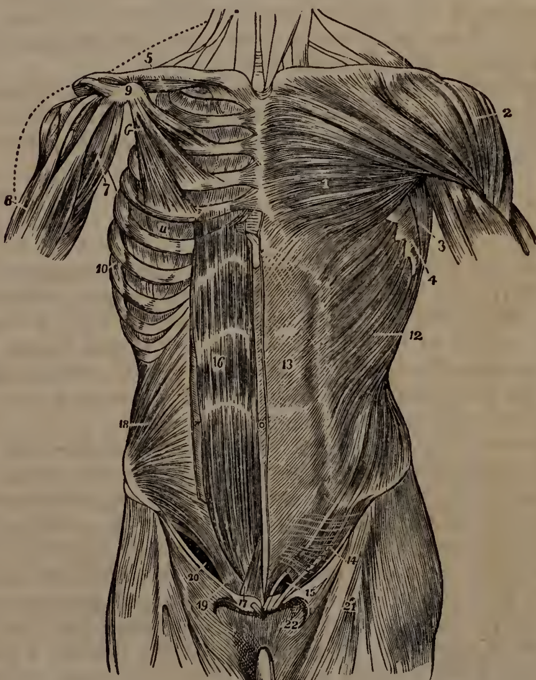
the cervical vertebræ tendinously. *Insertion,* into the upper surface of the first rib, behind the groove for the artery. *Use;* same as last.

Scalenus posticus.[8]—*Origin,* from the transverse processes of the fifth and sixth cervical vertebræ. *Insertion,* into the upper face of the second rib beyond the tubercle. *Use;* it bends the neck and raises the second rib.

MUSCLES OF THE CHEST.

Pectoralis major.[1]—Forms the cushion of the chest. *Origin,* from the two upper bones of the sternum, the sternal two-thirds of the

Fig. 59.



clavicle, the cartilages of the fifth and sixth ribs, and from the tendon of the external oblique muscle. *Insertion,* into the outer edge of the bicipital groove of the humerus. *Use;* it draws the arm inwards and forwards.

Pectoralis minor.[6]—*Origin,* from the third, fourth, and fifth ribs

Insertion, into the inner face of the extremity of the coracoid process of the scapula.[9] *Use;* it draws the scapula inwards and downwards.

Subclavius.[5] — *Origin*, from the cartilage of the first rib. *Insertion*, into the inferior face of the clavicle. *Use.* It draws the clavicle downwards.

Serratus magnus, or anticus.[4]—*Origin*, from the nine upper ribs, five of its heads interdigitating with the external oblique muscle. *Insertion*, into the whole length of the base of the scapula. *Use.* It draws the scapula forwards.

Intercostales externi.[11] — There are eleven on each side. *Origin*, from the transverse process of the vertebra, and the inferior sharp edge of the rib. *Insertion*, into the superior rounded edge of the rib below. The fibres pass obliquely downwards and forwards.

Intercostales interni.—Also eleven on each side. *Origin*, from the inferior edge of the rib, and costal cartilages. *Insertion*, into the superior rounded edge of the rib below, the fibres passing downwards and backwards. *Use.* To approximate the ribs.

Triangularis sterni. — Situated on the inner wall of the front of the chest. *Origin*, from the ensiform cartilage, and second bone of the sternum. *Insertion*, into the third, fourth, fifth, and sixth ribs. *Use.* To depress the ribs.

MUSCLES OF THE ABDOMEN.

Beneath the skin of the abdomen is the *fascia superficialis abdominis*, a layer of condensed cellular substance, varying in thickness in different individuals, and containing more or less fat. Its laminated character admits of its being dissected into several layers. In the groin it encloses the lymphatic glands, and is traversed at its lower part by the *arteria ad cutem abdominis;* it is thickened over the symphysis pubis, and constitutes the *mons veneris*.

Obliquus externus.[12]—*Origin*, from the eight inferior ribs, the first head being covered by the pectoralis major; the five superior heads interdigitate with those of the serratus anticus, and the three inferior, with those of the latissimus dorsi. The fibres pass obliquely downwards and forwards. *Insertion*, into the whole length of the linea alba, tendinously; into the anterior half or two-thirds of the crest of the ilium, by muscular and tendinous fibres; and into the body and crest of the pubes, forming thereby Poupart's ligament. As the tendinous fibres approach the pubes, they split, forming a triangular opening called the external abdominal ring;[15] through which passes in the male the spermatic cord, and in the female the round ligament of the uterus. The edges of this ring are called columns or pillars. To the edges of the ring is attached a thin fascia called inter-columnar or external spermatic, which is continued upon the cord and testicle.—This ring is prevented from splitting still further, by some transverse tendinous fibres. The external edge of that portion of the

tendon inserted into the crest of the pubis,[14] is called Gimbernat's ligament. (Fig. 59.)

Use.—It compresses the viscera of the abdomen, and approximates the pelvis and thorax.

Obliquus internus.[15]— *Origin*, from the three inferior spinous processes of the lumbar vertebræ, and from all those of the sacrum, from the whole length of the middle lip of the crest of the ilium, and from the outer half of Poupart's ligament. *Insertion*, into the six inferior ribs, into the ensiform cartilage, into the whole length of the *linea alba*, and also tendinously into the pubes behind the external abdominal ring. At the linea semilunaris, the tendon splits into two laminæ, which form a sheath for the rectus muscle; in the lower third or fourth of the muscle, both laminæ, however, pass in front, and include between them the pyramidalis muscle.

Transversalis abdominis.—Is beneath the last. *Origin*, from the transverse processes of the last dorsal and four upper lumbar vertebræ, from the internal lip of the crest of the ilium, and from the external half of Poupart's ligament; it also arises from the cartilages of the six inferior ribs. *Insertion*, into the ensiform cartilage, linea alba, and pubes, in common with the internal oblique tendon. A portion of this common tendinous insertion is also into the crest of the pubes immediately behind the external abdominal ring, and thus the weakness at this part of the abdomen is in some measure protected.

Rectus abdominis.[16]—*Origin*, from the symphysis and body of the pubes. *Insertion*, into the ensiform cartilage, and into the cartilages of the fifth, sixth, and seventh ribs. This muscle gradually increases in breadth and has tendinous intersections called *lineæ transversæ*, which are three or four in number.

Pyramidalis.[17]—Is in front of the lower part of the rectus, and about three inches in length. *Origin*, from the body of the pubes. *Insertion*, into the linea alba. It is sometimes wanting.

Cremaster.—This muscle forms a muscular sheath for the cord and upper part of the testicle. Before the descent of the testicle, it constitutes the inferior edge of the internal oblique and transversalis muscles, which are much blended at this part; hence its *origin* may be said to be the muscular portion of the lower edge of these muscles, and that its *insertion* is into the conjoined tendon of these muscles.

Fascia transversalis.—This fascia covers the abdomen, and lies under the muscles and in front of the peritoneum; it is continuous with the *iliac fascia*, which surrounds the posterior part of the peritoneum, and with the *pelvic fascia*, which surrounds that portion of peritoneum in the cavity of the pelvis. It is thin and tough, and near the groin possesses great density.

This fascia is an object of study, particularly on account of the *internal abdominal ring* being situated in it. This point is usually much misunderstood, partly from the use of the term *ring*, which gives rise to the idea that it is a hole or opening like the external ring, and

partly from the variety and confusion of terms employed in its description. It may be said to be that portion of the fascia transversalis where it ceases to cover the abdomen and commences to cover the cord; here it is very thin, and an artificial or false dissection readily can form a ring or hole with a well-defined edge. But such does not exist in nature, for the fascia is continued from the abdomen upon the cord under the name of the infundibiliform or internal spermatic fascia.

INGUINAL HERNIA.

Inguinal hernia is of two kinds; oblique or indirect, and direct or ventro-inguinal hernia. Oblique is by far the most common; and in order to understand the anatomy of it, it will be necessary to bear in mind the arrangement of the parts previous to the descent of the testicle, the subsequent and natural condition, and also the alteration of the parts by the hernial protrusion.

Oblique inguinal hernia is a protrusion of intestine, through a passage originally made by the escape of the testicle from the loins to the scrotum; and afterwards occupied by the spermatic cord. Until the seventh month of fœtal life the testicle reposes in the lumbar region beneath the kidney, but not within the cavity of the peritoneum. As yet there is no spermatic cord formed, the constituents, to wit, the artery, vein, and duct, approach the testicle separately. About this period the testicle ordinarily descends, by means of the *gubernaculum testis*, a contractile structure attached to its inferior extremity, and is enveloped in the scrotum. In its passage it must come in contact with the various structures forming the parietes of the abdomen, viz., the peritoneum, fascia transversalis, the transversalis, internal and external oblique muscles, the superficial fascia, and the skin. Each of these structures, with the exception of the external oblique muscle, will be found to form a covering for the testicle, because it does not perforate them but pushes them before it; although these coverings may be modified in some degree, nevertheless there is a representation of every layer of the walls of the abdomen; and this is the case not only in the coverings of the testicle and cord, but also in the coverings of a hernia protrusion; hence, if a student understands the changes which take place in the descent of the testicle, he must necessarily understand the mode by which this kind of a hernial protrusion obtains its coverings.

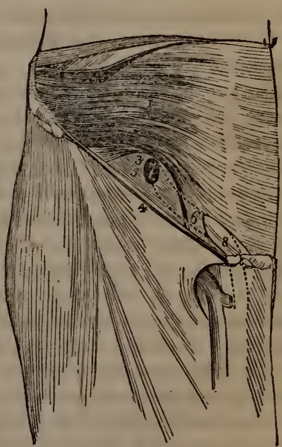
Here we must caution students from attaching too much importance to words or terms used in description, for they vary with different writers; but let him keep constantly before his mind the thing itself, as if he were making a dissection; for by actual dissection he can understand it thoroughly, although he may not know the name of a single part.

Descent of the testicle.—By the contraction of the gubernaculum testis, the testicle which lies exterior to the peritoneal cavity, pushes

before it two laminæ of peritoneum. Thus the testicle gets a covering of serous membrane arranged as serous membranes always are; that is, one lamina covers the testicle, and the other lines the cavity in which it is contained, and it is called the *peritestis* or *tunica vaginalis testis.* The communication between the peritoneum and peritestis is afterwards obliterated, otherwise the bowel could readily pass down; and when this obliteration does not occur, and the bowel does pass down, it constitutes a variety of hernia, termed *congenital.* As the testicle descends, the spermatic artery, vein, and vas deferens descend with it, and thus the cord is formed, the components being held together by means of cellular tissue — the remains of the canal of peritoneum, connecting the peritoneum and peritestis.

Now, the next structure with which the testicle comes in contact, is the fascia transversalis; let us follow this in its descent with the testicle, and observe the changes which it undergoes. It is not perforated as this (Fig. 60) and most pictures represent,[7] but pushed before the testicle, covering it and the cord. The point where this protrusion takes place, is midway between the anterior superior spinous process of the ilium and the pubes, and about an inch and a half above Poupart's ligament, and is called the *internal abdominal ring;* but there is no hole or opening in the fascia unless made with a scalpel. The fascia is continuous from the abdomen upon the cord, although that portion covering the abdomen is tougher and thicker than that of the cord. If the cord is stretched, this portion of the fascia will resemble a funnel, and hence some call it the *infundibuliform fascia* or *internal spermatic fascia.*

Fig. 60.



Terms are matters of minor importance; the truth to be taught is, that the testicle, cord, and abdomen are invested by the same fasciæ, having different names and different thicknesses in different parts.

The next layer of the abdominal wall with which the testicle comes in contact is the *transversalis muscle.* At the lower part of the abdomen, the internal oblique is so much blended with the transversalis, that the two may be considered as having the same relation to the testicle in its descent, and also to hernia. At the internal abdominal ring, the testicle, already covered by the peritoneum and fascia trans-

versalis, comes in contact with these muscles; it does not perforate them, but pushes their conjoined lower edge before it, obtains for itself and cord a muscular covering, which is the *cremaster* muscle; and this accounts for that looped appearance which the fibres of this muscle have upon the testicle; also, for the muscle being thicker upon the anterior part of the cord. These muscular fibres are very pale, and very scattered upon the lower part of the testicle, and form an imperfect covering for the testicle. When the cremaster is cut away from the transversalis and internal oblique muscles, their inferior edge presents an arched appearance.

The tendon of the external oblique is the next structure opposing its descent, and since this is very tough, it is not pushed before the testicle; but the testicle passes obliquely downwards and inwards for an inch and a half, until it gets opposite the external abdominal ring, and at which it emerges between its columns or pillars. The fact, that in health these two rings are not opposite contributes much to the strength of the arrangement, and prevents the more frequent occurrence of hernia, which is much favoured by a deficiency in the fibrous character of the tendon of the external oblique.

The space between these two rings, is called the *inguinal, abdominal* or *spermatic canal.*[7 6 8] It is bounded anteriorly by the inferior edge of the internal oblique and transversalis muscles, the tendon of the external oblique, the superficial fascia and skin; posteriorly by the transversalis fascia, and the conjoined tendon of the transversalis and internal oblique muscles; inferiorly, by Poupart's ligament.

When the hernia does not emerge from this canal, it is called a *concealed* inguinal hernia.

At the external abdominal ring, the testicle, with its coverings, comes in contact with the *intercolumnar*, or, *external spermatic fascia*, which has already been described as extending between the columns of the ring. It is afterwards covered by the superficial fascia and skin. The superficial fascia of the testicle is blended with that portion of the transversalis fascia covering the testicle, on account of the intervening muscular structures—the cremaster, being deficient in some parts, and very spare in others.

The skin is, of course, readily traced from the abdomen to the scrotum, although in the scrotum it is modified by the dartos, which, according to some, is an expansion of the gubernaculum testis.

We have seen the changes which take place in the descent of the testicle, and are now prepared to consider the escape of the intestine.

The convolution or knuckle of intestine first presses against the peritoneum, and being contained within the cavity, can only push before it a single lamina. This portion of the peritoneum always forms the *hernial sac*, which gradually increases in size and thickness. In this variety of hernia (oblique inguinal), the protrusion takes place at the internal ring; the sac must then necessarily be covered by the transversalis fascia and cremaster muscle, and after passing

obliquely down the inguinal canal, it emerges at the external abdominal ring, where it receives an investment of the external spermatic, and superficial fasciæ, and also of the skin.

That portion of the superficial fascia which fills up the external abdominal ring between its columns, and called intercolumnar, when pressed against by the protrusion is thickened and expanded.

Hence, in the operation for hernia, the following layers are cut through :—

Skin, superficial fascia, intercolumnar or *external spermatic fascia, cremaster muscle, transversalis* or *internal spermatic fascia,* and *the hernial sac.*

In the dissection of a hernial sac, we will find alterations in thickness and colour, the consideration of which properly belongs to the surgical part of this work.

Direct or *ventro-inguinal hernia* consists of a protrusion directly at the external abdominal ring, and of course it does not pass through the canal. The coverings are the *skin, superficial fascia, intercolumnar* or *external spermatic fascia,* the common *tendon* of the *internal oblique* and *transversalis* muscles, *transversalis* or *internal spermatic fascia,* and hernial *sac.*

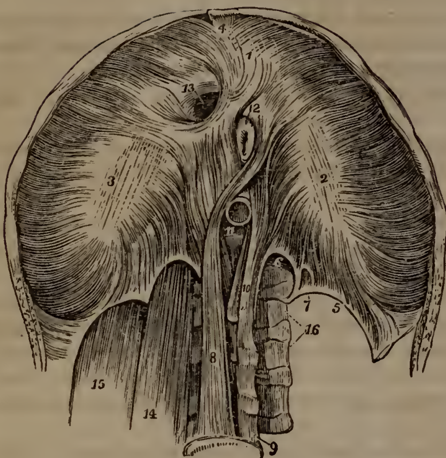
This variety is not of so frequent occurrence, on account of the insertion of the tendon of the internal oblique and transversalis into the pubes immediately behind the external abdominal ring, which protects this opening, and therefore it must be ruptured or expanded when a protrusion takes place at this ring; when it is ruptured, of course this covering of the sac does not exist.

MUSCLES OF THE UPPER AND POSTERIOR PART OF THE ABDOMEN.

Diaphragm.—This muscle forms the septum between the thorax and abdomen; it consists of two parts, a greater and lesser muscle. The *greater*[1 2 3] muscle arises from the ensiform cartilage, from the ligamentum arcuatum,[5] which is a tense ligament passing from the root of the transverse process of the first lumbar vertebra to the inferior part of the middle of the twelfth rib, and from six inferior ribs; the fibres converge to the cordiform tendon, which is in the centre. Between its costal and ensiform origin there is a small triangular fissure filled up with fat, which sometimes leaves an opening for hernia. The *lesser*[8 10] muscle consists of two bellies, which are called *crura,* the right of which is the larger. *Origin,* from the second, third, and fourth lumbar vertebræ. *Insertion,* into the cordiform tendon.

There are *three openings* in the diaphragm; one in the tendinous centre,[13] called *foramen quadratum,* which transmits the ascending *vena cava;* another, an elliptical muscular opening,[12] called *foramen œosophageum,* through which passes the œsophagus, and the par vagum nerves; and the third, the *hiatus aorticus,*[11] which is between the crura, and in front of the vertebra; through it pass the aorta, the

Fig. 61.



thoracic duct, the azygos vein, and the great splanchnic nerve. *Use;* it widens the thoracic, and diminishes the abdominal cavity.

Quadratus lumborum. — *Origin,*[15] from the crest of the ilium. *Insertion,* into the transverse processes of the last dorsal and all the lumbar vertebræ, and also into the last rib beneath the ligamentum arcuatum. *Use;* it bends the loins to one side.

Psoas parvus.—Not always present. *Origin,* from the last dorsal and first lumbar vertebræ. *Insertion,* by a long tendon, into the *crest of the pubes* and *fascia iliaca.*

Psoas magnus.[14]—*Origin,* from the transverse processes of all the lumbar vertebræ, and from the bodies of the four upper lumbar and last dorsal vertebræ. *Insertion,* into the lesser trochanter of the femur, and into one inch below it.

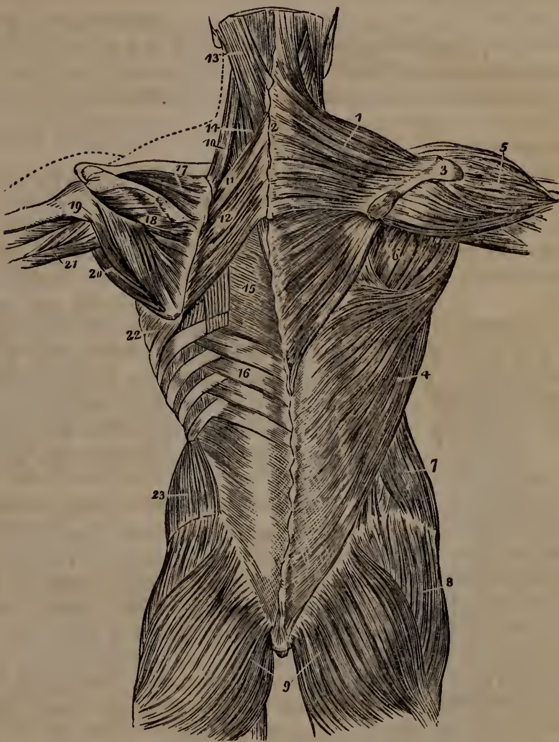
Iliacus internus.[15]—*Origin,* from the transverse process of the last lumbar vertebra, from the costa and crest of the ilium, and from the capsule of the hip joint. *Insertion,* into the tendon of the psoas magnus. *Use;* the action of the last two muscles is the same, to bend the body forwards and draw the thigh upwards.

MUSCLES OF THE BACK.

Trapezius.[1]—*Origin,* from the superior semicircular ridge of the occiput, from all the spinous processes of the neck, by means of the ligamentum nuchæ, and from all those of the back. *Insertion,* into the external third of the clavicle, into the acromion process, and spine of the scapula. *Use;* it draws the scapula towards the spine.

Latissimus dorsi.[4]—*Origin,* from the seven inferior spinous processes of the back, and from all those of the loins and sacrum, also from four inferior ribs, by heads which interdigitate with those of the external oblique. *Insertion,* by a thick flat tendon, in common with the *teres major,* into the posterior ridge of the bicipital groove. *Use;* it draws the humerus downwards and backwards.

Fig. 62.



Serratus posticus inferior.[16]—*Origin*, from the two inferior spinous processes of the back, and the three superior of the loins. *Insertion*, into the last four ribs. *Use;* it draws the ribs downwards.

Rhomboideus minor.[11]—*Origin*, from the three inferior spinous processes of the neck. *Insertion*, into the base of the scapula opposite the spine.

Rhomboideus major.[12]—*Origin*, from the spinous processes of the last cervical, and of the four superior dorsal vertebræ. *Insertion*, into the base of the scapula below the spine. *Use;* the last two draw the scapula upwards and backwards.

Serratus posticus superior.—*Origin*, from the three inferior spinous processes of the neck, and the two superior of the back. *Insertion*, into the second, third, fourth, and fifth ribs. *Use;* it draws the ribs upwards.

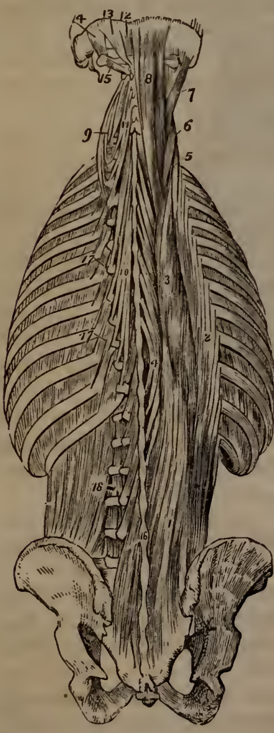
Levator anguli scapulæ.[10]—*Origin*, from the transverse processes of the three, four, or five superior cervical vertebræ. *Insertion*, into

the angle of the scapula, and its base above the spine. *Use;* it draws the scapula upwards.

Splenius.[13 14]—It consists of two parts; splenius capitis and splenius colli. *Origin*, from the spinous processes of the five inferior cervical and the four superior dorsal vertebræ. *Insertion*, into the occipital bone, between the two semicircular ridges, and into the transverse processes of the two superior cervical vertebræ. *Use;* draws the head and neck backwards.

Sacro-lumbalis and *longissimus dorsi.*—These two muscles arise in common (Fig. 63.) *Origin*, from the spinous and transverse processes of the loins and sacrum, and from the crest of the ilium. The first[2] is on the outer side. *Insertion*, into the angles of the rib. The latter[3] is nearest the spine. *Insertion*, into all the transverse processes of the back except the first, and into all the ribs beyond their tubercles, except the last two. *Use;* to keep the spine erect, and draw down the ribs.

Fig. 63.



Accessorii ad sacro-lumbalem.—Are muscular slips arising from the eight lower ribs and continued into the sacro-lumbalis.

Spinalis dorsi.[4]—*Origin*, from the three inferior spinous processes of the back, and two superior of the loins. *Insertion*, into the nine superior spinous processes of the back, except the first. *Use;* to keep the spine erect.

Cervicalis descendens.[5]—*Origin*, from the four superior ribs. *Insertion*, into the fourth, fifth, and sixth transverse processes of the neck.

Transversalis cervicis.[6 9]—*Origin*, from the five superior transverse processes of the back. *Insertion*, into the five middle transverse processes of the neck. *Use;* the two last draw the neck backward.

Trachelo-mastoid.[7]—*Origin*, from the three superior transverse processes of the back and from the five inferior transverse processes of the neck. *Insertion*, into the mastoid process.

Complexus.[8]—*Origin*, from the transverse processes of the four inferior cervical and seven superior dorsal, and from the spinous process of the first dorsal vertebra. *Insertion*, into the occiput between its semicircular ridges. *Use;* the two last draw the head backward.

Semi-spinalis cervicis.[11]—*Origin,* from the six superior transverse processes of the back. *Insertion,* into the spinous processes of the five middle cervical vertebræ.

Semi-spinalis dorsi.[10]—*Origin,* from the transverse processes of the seventh, eighth, ninth, and tenth dorsal vertebræ. *Insertion,* into the spinous processes of the two lower cervical, and five upper dorsal vertebræ.

Multifidus spinæ.[16]—*Origin,* from the posterior surface of the sacrum, and the back part of the ilium, and from the oblique and transverse processes of all the vertebræ of the loins and back, and of the four inferior of the neck. *Insertion,* into the spinous processes of all the vertebræ of the loins and back, and of the five inferior of the neck. *Use;* the three last twist the spine when acting without their fellows.

Rectus capitis posticus major.[13]—*Origin,* from the spinous process of the dentata. *Insertion,* into the occiput at its superior semi-circular ridge, and below it. *Use;* it turns the head.

Rectus capitis posticus minor.[12]—*Origin,* from the tubercle of the atlas. *Insertion,* into the occiput, at the inferior semi-circular ridge, and below it.

Obliquus superior.[14]—*Origin,* from the transverse process of the atlas. *Insertion,* into the outer end of the inferior semi-circular ridge of the occiput.

Obliquus inferior.[15]—*Origin,* from the spinous process of the dentata. *Insertion,* into the transverse process of the atlas.

Interspinales.—Between the spinous processes of all the vertebræ. In the neck, they are double: in the back, tendinous; in the loins, single and well-marked.

Inter-transversarii.[18]—Between all the transverse processes. In the neck, double; in the back, tendinous; in the loins fleshy and single. *Use.* To approximate these processes.

Levatores costarum.[17]—*Origin,* from the transverse processes of the last cervical and eleven upper dorsal vertebræ. *Insertion,* into the upper edge of the rib below, and sometimes into the second rib below. *Use.* To elevate the ribs.

MUSCLES OF THE SHOULDER AND ARM.

FASCIA.

The brachial fascia covers the muscles of the upper extremity, commencing at the spine of the scapula and clavicle. Upon the deltoid it is thin. At the elbow it sends several processes to the bone, which serve for the origin of muscles, and in front it receives a portion of tendon from the biceps muscle, which render it tense.

At the wrist it forms the anterior and posterior annular ligaments, which bind down the tendons of the hand, and in the hand it forms the palmar aponeurosis.

Deltoid.[5]—*Origin*, from the spine of the scapula, its acromion process, and the external third of the clavicle. *Insertion*, into a triangular roughness near the middle of the outer side of the humerus. *Use.* It raises the humerus. (Fig. 62.)

Supra-spinatus.[17]—*Origin*, from the whole of the fossa supra-spinata. *Insertion*, into the inner facet of the greater tuberosity of the humerus. *Use.* It raises the arm and turns it outwards.

Infra-spinatus.[18]—*Origin*, from the whole of the fossa infra-spinata. *Insertion*, into the middle facet of the greater tuberosity of the humerus. *Use.* It rotates the humerus outwards and backwards.

Teres minor.[19]—*Origin*, from the lesser costa of the scapula. *Insertion*, into the outer facet of the greater tuberosity of the humerus. *Use.* It rotates the humerus outwards, and draws it downwards and backwards.

Teres major.[20]—*Origin*, from the posterior surface of the inferior angle of the scapula, and a part of its lesser costa. *Insertion*, into the posterior edge of the bicipital groove of the humerus in common with the tendon of the latissimus dorsi. *Use.* It rotates the humerus inwards and draws it downwards and backwards.

Subscapularis.[4] (Fig. 64.) *Origin*, from the whole of the costa of the scapula. *Insertion*, into the lesser tuberosity of the humerus. *Use.* It rotates the humerus inwards, and draws it downwards.

Fig. 64.

Biceps flexor cubiti.[7]—*Origin*, from the superior extremity of the glenoid cavity, by a long tendon which passes through the joint and bicipital groove, and by a short head from the coracoid process of the scapula. *Insertion*, into the posterior and inferior parts of the tubercle of the radius, and into the brachial fascia. *Use.* It flexes the fore-arm.

Coraco-brachialis.[6]—*Origin*, from the middle facet of the coronoid process of the scapula, in common with the short head of the biceps. *Insertion*, into the middle of the os humeri by a rough ridge on its internal side. *Use.* It draws the arm upwards and inwards.

Brachialis Internus.[9]—*Origin*, from the anterior and lower half of the os humeri. *Insertion*, in front of the base of the coronoid process of the ulna. *Use.* It flexes the fore-arm.

Triceps extensor cubiti.[10]—*Origin*, by three heads; the first or longus, is from the inferior part of the glenoid cavity. The second or external, is from a ridge from the back part of the os humeri, just

below its head; and the third or brevis, is from the inner side of the os humeri, near the bicipital groove. *Insertion*, into the olecranon process of the ulna. *Use.* It extends the fore-arm.

Anconeus.[11] (Fig. 67.)—*Origin*, from the external condyle of the humerus. *Insertion*, into the óuter side of the ulna below the olecranon. *Use.* It extends the fore-arm.

MUSCLES OF THE FORE-ARM.

These are eighteen in number, eight of which are on the front of the arm, and are flexors; for the most part they arise from the internal condyle. The remaining ten are extensors, and arise for the most part from the external condyle.

Fig. 65.

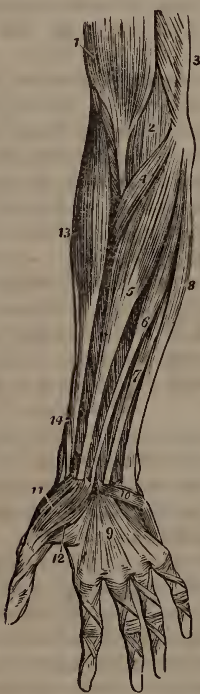


Fig. 66.

Pronator radii teres.[4] (Fig. 65.)—*Origin*, from the internal condyle of the humerus, and the coronoid process of the ulna. *Insertion*, into the middle and external side of the radius. *Use.* It rotates the hand inwards.

Flexor carpi radialis.[5] — *Origin,* from the internal condyle of the humerus, the brachial fascia, and the inter-muscular septa. *Insertion,* into the base of the metacarpal bone of the index finger. *Use;* it flexes the hand at the wrist. (Fig. 65.)

Palmaris longus.[6]—Is sometimes deficient. *Origin,* from the internal condyle. *Insertion,* into the annular ligament and palmar aponeurosis. *Use;* it bends the hand.

Flexor carpi ulnaris.[8] — *Origin,* from the internal condyle, from the ridge at the inner side of the ulna and from the olecranon. *Insertion,* into the pisiform bone and into the base of the metacarpal bone of the little finger. *Use;* it flexes the hand.

Flexor sublimis digitorum perforatus.[7]— *Origin,* from the internal condyle of the humerus, the coronoid process of the ulna, and the tubercle of the radius. *Insertion,* by four split tendons into the second phalanges of the fingers. *Use;* it bends the hand and fingers.

Fig. 67.

Flexor profundus digitorum perforans.[4] (Fig. 66.)—*Origin,* from the ulna by its anterior flat surface, from its coronoid process, and from the interosseous ligament. *Insertion,* by four tendons, which, passing through the perforations in the tendons of the flexor sublimis, are inserted into the third phalanges of the fingers.

Flexor longus pollicis.[5]— *Origin,* from the internal condyle of the humerus, and the middle two-thirds of the radius, and a part of the interosseous ligament. *Insertion,* into the base of the second phalanx of the thumb. (Fig. 66.)

Pronator quadratus.[6] — *Origin,* from the inner border and anterior surface of the ulna, near its lower extremity. *Insertion,* into the corresponding surface of the radius. *Use;* it rotates the radius inwards.

Supinator radii longus.[4] (Fig. 67.) — *Origin,* from the ridge leading to the external condyle of the humerus. *Insertion,* into the radius just above its styloid process. *Use;* it rotates the radius outwards.

Extensor carpi radialis longior.[5]—(Fig. 67.) *Origin,* from the ridge of the external condyle of the humerus. *Insertion,* into the posterior part of the base of the *metacarpal* bone of the forefinger.

Extensor carpi radialis brevior.[6]— *Origin,* from the external con-

dyle of the humerus, and from the external lateral ligament. *Insertion*, into the posterior part of the base of the metacarpal bone of the middle finger.

Extensor carpi ulnaris.[10]— *Origin*, from the external condyle and the brachial fascia. *Insertion*, into the base of the metacarpal bone of the little finger. *Use;* the last three extend the hand.

Extensor digitorum communis.[8] — *Origin*, from the external condyle. *Insertion*, by four tendons which are connected by slips previous to their insertion into all the phalanges of the fingers. *Use;* it extends the joints of the fingers.

Supinator radii brevis. — *Origin*, from the external condyle, and from a ridge of the ulna on its posterior surface. *Insertion*, into the radius between its tubercle and the insertion of the pronator. *Use;* it rotates the radius outwards.

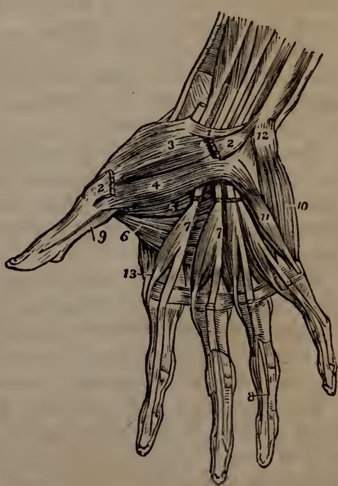
Extensor ossis metacarpi pollicis manus.— *Origin*, from the posterior surface of the ulna, from the interosseous ligament, and a part of the radius. *Insertion*, into the base of the metacarpal bone of the thumb, and into the trapezium.

Extensor minor pollicis manus.[13] — *Origin*, from the back of the ulna below its middle, and from the interosseous ligament. *Insertion*, into the first phalanx of the thumb.

Extensor major pollicis manus.[14] — *Origin*, from the back of the ulna above its middle, from the interosseous ligament, and from the back of the radius. *Insertion*, into the base of the second phalanx of the thumb. *Use;* these last three extend the thumb.

Indicator.— *Origin*, from the back of the ulna, and interosseous ligament. *Insertion*, into the base of the first phalanx of the index finger. *Use;* it extends the forefinger.

Fig. 68.



MUSCLES OF THE HAND.

Palmaris brevis. — *Origin*, from the anterior ligament of the wrist, and palmar aponeurosis. *Insertion*, into the skin at the inner edge of the hand. *Use;* it contracts the skin.

Lumbricales.[7]—These are four in number, and resemble earthworms. *Origin*, from the tendons of the flexor profundus. *Insertion*, into the radial side of the base of the first phalanx of each finger. *Use;* they assist in bending the fingers. (Fig. 68.)

Abductor pollicis manus.[2] —

Origin, from the annular ligament, trapezium, and scaphoid bones. *Insertion*, into the base of the first phalanx of the thumb. *Use;* it draws the thumb from the fingers.

Opponens pollicis.[3]—*Origin*, from the trapezium and annular ligament. *Insertion*, into the radial edge of the metacarpal bone, from its base to its head. *Use;* it draws the metacarpal bone inwards.

Flexor brevis pollicis manus.[4 5]—It consists of two bellies. The external *arises* from the trapezium and trapezoides, and the annular ligament; and it is inserted into the outer side of the first phalanx of the thumb. The internal head *arises* from the magnum and unciform, and the metacarpal bone of the little finger, and it is inserted into the inner side of the base of the first phalanx of the thumb. The sesamoid bones are included in these tendons.

Adductor pollicis manus.[6]—*Origin*, from the metacarpal bone of the middle finger between its base and its head. *Insertion*, into the base of the first phalanx of the thumb. *Use;* it draws the thumb towards the fingers.

Abductor minimi digiti manus.[10]—*Origin*, from the pisiform bone, and annular ligament. *Insertion*, into the ulnar side of the base of the first phalanx of the little finger. *Use;* it draws the little finger from the rest.

Flexor parvus minimi digiti.[11]—*Origin*, from the unciform process of the unciform bone, and annular ligament. *Insertion*, into the ulnar side of the base of the first phalanx of the little finger. *Use;* it bends the little finger.

Adductor metacarpi minimi digiti.—*Origin*, from the unciform process and annular ligament. *Insertion*, into the metacarpal bone of the little finger, from its base to its head. *Use;* it brings the metacarpal bone towards the wrist.

Interosseous muscles.—These are seven in number; three of which are on the *palmar* side, and four on the *dorsal* side. The palmar interossei are *adductors*, the dorsal are *abductors* with reference to the median line of the hand.

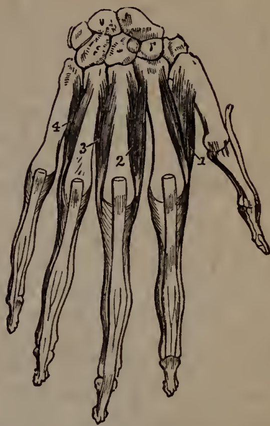
The *palmar interosseous muscles.* (Fig. 69.)—These arise from the base of the metacarpal bone of one finger, and are inserted into the base of the first phalanx of the same finger. The first belongs to the index finger,[1] the second to the ring finger,[2] and the third to the little finger.[3]

The *dorsal interosseous* are penniform, arising by two heads from adjoining sides of the metacarpal bones. (Fig. 70.) They are inserted into the bases of the first phalanges; the first into the index finger,[1] the second and third into the middle finger,[2 3] compensating its exclusion from the palmar group; the fourth into the ring finger.[4]

The diversified and confused description of these muscles by different authors, is owing to the use of terms that are not significant, a want of proper classification, and the dividing of one muscle in two, and calling the different portions of it by different names; thus, some

Fig. 69.

Fig. 70.



enumerate four *palmar* and three *dorsal* interossei, together with the muscle called *abductor indicis;* others, again, enumerate four palmar and four dorsal. The principle of classification should be with regard to their *action.* Whether they are abductors or adductors, with reference to an axis passing through the middle finger. If the first dorsal interosseous is split into two muscles, and that portion arising from the metacarpal bone of the thumb, is called the *abductor indicis*, and the remaining portion counted among the palmar interossei, the various modes of classifying these muscles can easily be understood.

MUSCLES OF THE LOWER EXTREMITY.

The lower extremity is covered by a dense fascia called *fascia lata*, which commences at the crest of the ilium, and extending over the glutei muscles, reaches to the foot. In the front of the thigh it is termed *iliac* and *pubic*, with reference to its proximity to these bones. At the knee, it forms a general covering, called the *involucrum;* in the leg it is termed the *crural fascia;* in front of the ankle it constitutes the *annular ligament*, which binds down the extensor tendons; under the sinuosity of the os calcis, it binds down the flexor tendons in the form of the *ligamentum laciniatum*, or plaited ligament; finally, it terminates in the *plantar fascia*, that firm aponeurosis upon the sole of the foot. From it are formed numerous sheaths for muscles and tendons.

ANATOMY OF FEMORAL HERNIA.

This variety of hernia is a protrusion of intestine at an opening near the passage of the large vessels to and from the thigh. We shall at first describe the parts as they occur upon dissection, and then the descent of the gut.

Upon the removal of the skin from the upper portion of the thigh the *superficial fascia* is brought into view. This fascia is a continuation of the superficial fascia of the abdomen, and like it is capable of being dissected in laminæ. In the groin it contains numerous lymphatic glands. It is traversed by the *saphena vein*, which enters the femoral vein, through the *saphenous opening* of the fascia lata, about an inch below Poupart's ligament.

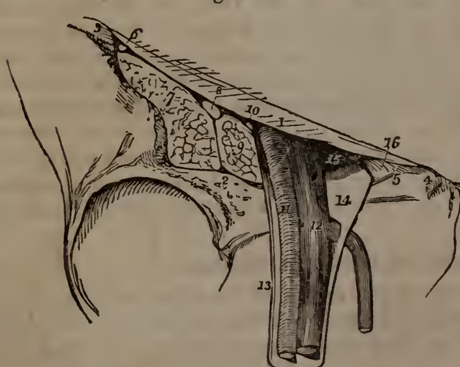
Having removed this fascia we bring into view the *fascia lata* of the thigh. This fascia is of a pearly white colour and very dense structure. It consists of two portions, the sartorial and pectineal. The *sartorial* portion [1] is upon the iliac side, and is connected at its upper part with Poupart's ligament. It passes in front of the sheath of the vessels, and has a crescentic edge on its inner side, called the *falciform* process. This process limits the saphenous opening on its outer side; and in order that this edge should be distinctly seen, a layer of superficial fascia with which it is continuous must be carefully removed; this portion of superficial fascia which fills up the saphenous opening is often called *cribriform fascia*. (See Fig. 60.)

The superior horn of this crescentic falciform process is twisted and inserted in the crest of the pubes, external to, but continuous with, Gimbernat's ligament, and is called *Hey's* ligament.

The *pectineal* portion of the fascia lata is upon the pubic side; it is thinner than the sartorial and passes behind the sheath of the vessels.

The sheath of the vessels is formed of condensed cellular tissue, and may be considered a prolongation of the fascia transversalis and fascia iliaca. It is usually compared to the tubular portion of a funnel; the abdominal portions of these fasciæ constituting the larger and upper part of the funnel. Numerous perforations exist in the sheath of the vessels for the passage of veins and absorbents which renders it cribriform. One of these perforations can be seen where the sheath is laid open, and also the saphena vein entering the femoral vein.[12] Since the artery [11] and vein [12] are cylinders, it must be evident that there must be some structure filling up the intervening spaces, and also the space [15] between the vein and Gimbernat's ligament,[16] or else there would be a deficiency of structure. Now this space between the vein and Gimbernat's ligament, is the *crural*

Fig. 71.



ring,[15] and is filled up with loose cellular tissue, and a lymphatic gland. This cellular tissue is called by some the *crural septum*, by others *fascia propria*, and *cribriform fascia*. A weakness of this septum between the cavity and tube of the funnel predisposes to hernia. The crural or femoral ring is *bounded* in front by Poupart's ligament; behind, by the bone; on the inside by Hey's and Gimbernat's ligament; on the outside by the vein. The femoral vessels,[11, 12] with their sheath,[13] together with the iliacus internus[7] and psoas magnus[9] muscles, pass out under Poupart's ligament, and thus fill the crural arch.

The intestine in femoral hernia pursues the following course. The peritoneum, as in all other instances, is at first distended and forms the hernial sac; this distension takes place at the crural ring, this being the only spot where it can occur under the crural arch; the *crural septum* or fascia propria[15] is now stretched and thickened; gradually yielding, it forms the next covering of the gut. With these it descends through the sheath of the vessels, and when it gets below the falciform process, emerges at one of the foramina for veins or absorbents; then it comes in contact with the superficial fascia, which forms another covering, and the skin forms the last.

In reaching the intestine by an operation for hernia, the order of coverings would be first, the *skin*, second, the *superficial fascia*, including that portion of it which some call *cribriform fascia*, third, the *fascia propria*, which was originally the crural septum, which some also call cribriform fascia, and fourth, the *hernial sac*, containing the protruding intestine. Much alteration of structure would of course exist by the parts becoming thicker and more laminated. In some instances the foramen of the sheath is not sufficiently large, and then the sheath is distended and consolidated with the other coverings. Many restrict the term *fascia propria* to this consolidated covering.

A femoral hernia may be concealed either above or below the saphenous opening; then of course the fascia lata will also form one of its coverings. (See SURGERY.)

Fig. 72.

MUSCLES OF THE HIP AND THIGH.

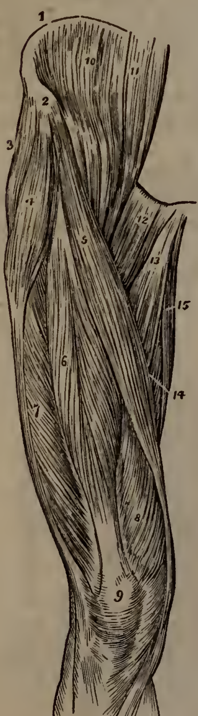
Gluteus maximus.[9] (Fig. 62.)—*Origin.* From the crest and from a portion of the dorsum of the ilium, from the sides of the sacrum and coccyx, and from the greater sacro-

sciatic ligament. *Insertion.* Into the upper third of the linea aspera, and into the fascia femoris. *Use.* It draws the thigh backwards, and keeps the trunk erect.

Gluteus medius.[8] (Fig. 62.)—*Origin.* From the dorsum of the ilium between the crest and semicircular ridge, from between the anterior spinous processes, and from the fascia femoris. *Insertion.* Into the upper and outer surface of the trochanter major. *Use;* it draws the thigh backwards and outwards.

Gluteus minimus.[8] (Fig. 72.)—*Origin.* From the dorsum of the ilium, between the semicircular ridge and the capsular ligament. *Insertion.* Into the trochanter major in front and below that of the medius. *Use.* It abducts and rotates the thigh inwards.

Fig. 73.



Pyriformis.[9]—*Origin,* from the second, third, and fourth bones of the sacrum. *Insertion.* Into top of the trochanter major. *Use.* It rotates the limb outwards.

Gemini.[10] [12]—These are two in number; the superior arises from the spinous process of the ischium, and the inferior from the tuberosity of the ischium; both are inserted in common with the tendon of the obturator internus.

Obturator internus.[11]—*Origin.* From the margin of the thyroid foramen, the internal surface of the thyroid ligament, and from the fascia iliaca. *Insertion.* Into the digital fossa of the femur.

Quadratus femoris.[13]—*Origin.* From the tuberosity of the ischium. *Insertion.* Into the femur between the two trochanters.

Obturator externus.—*Origin.* From the anterior margin of the thyroid foramen, and ligament. *Insertion.* Into the digital fossa at the root of the trochanter major. *Use.* The last four rotate the thigh outwards.

Biceps flexor cruris.[16]—*Origin.* By a long head in common with the semi-tendinosus from the tuberosity of the ischium, and by a short fleshy one from the lower part of the linea aspera. *Insertion.* Into the head of the fibula.

Semi-tendinosus.[18]—*Origin.* From the tuberosity of the ischium. *Insertion.* Into the side of the head of the tibia just below its tubercle.

Semi-membranosus.—*Origin.* From the external part of the tuberosity of the ischium. *Insertion.* Into a groove at the posterior and internal side of the head of the tibia, and it is also connected with the ligament of Winslow and the external condyle of the femur.

Tensor vaginæ femoris.[4]—(Fig. 73.) *Origin.* From the anterior superior spinous process of the ilium. *Insertion.* Into the fascia or sheath of the thigh.

Sartorius.[5]—*Origin.* From the anterior superior spinous process of the ilium. *Insertion.* Into the inner side of the head of the tibia. *Use.* It bends the leg and draws it inwards. It is the longest muscle of the body.

Rectus femoris.[6]— *Origin.* By two tendons, one from the anterior inferior spinous process of the ilium, and the other from the edge of the acetabulum. *Insertion.* Into the upper surface of the patella.

Vastus externus.[7]—*Origin.* From the linea aspera, and trochanter major. *Insertion.* Into the upper and external part of the patella.

Vastus internus.[8]— *Origin.* From the linea aspera in its whole length, covering the inside of the thigh. *Insertion.* Into the common tendon of the patella.

Cruræus.—*Origin.* From the anterior part of the femur as well as from the linea aspera. *Insertion.* Into the patella.

These four last muscles, often called the *quadriceps femoris*, form a common tendon in which is placed the patella, before it is inserted into the tubercle of the tibia. It extends the leg.

Gracilis.[15]—*Origin.* From the body and ramus of the pubes. *Insertion.* Into the inside of the head of the tibia.

Pectineus.[12]—*Origin.* From the crest of the pubes, and the triangular face in front of it. *Insertion.* Into the linea aspera below the trochanter minor.

Adductor longus.[13]—*Origin.* From the body of the pubes. *Insertion.* Into the middle third of the linea aspera.

Adductor brevis.—*Origin.* From the body and ramus of the pubes. *Insertion.* Into the upper third of the linea aspera.

Adductor magnus.[14]— *Origin.* From the body and ramus of the pubes, and from the ramus of the ischium. *Insertion.* Into the whole length of the linea aspera. At the junction of the middle and lower thirds of its insertion it is perforated by the femoral artery. *Use.* These four last draw the thigh forwards and inwards.

MUSCLES OF THE LEG.

Tibialis anticus[3] (Fig. 74.)—*Origin*, from the outer side and head of the tibia and from the interosseous ligament. *Insertion*, into the base of the internal cuneiform bone, and base of the first metatarsal bone.

Extensor Longus Digitorum Pedis.[3]—*Origin*, from the head of the fibula, the head of the tibia, and from a portion of the interosseous ligament, and edge of the fibula. *Insertion*, by four tendons into the phalanges of the four lesser toes.

Peroneus Tertius.[6]—*Origin*, from the anterior angle of the fibula, below its middle. *Insertion*, into the upper surface of the base of

the metatarsal bone of the little toe. It looks like a portion of the last-named muscle.

Extensor Proprius Pollicis Pedis.[6] — *Origin*, from the lower two-thirds of the fibula and interosseous ligament. *Insertion*, into the bases of the first and second phalanges of the great toe. *Use;* it extends the great toe.

Peroneous Longus.[7] — *Origin*, from the head and upper third of the outer side of the fibula. *Insertion*, into the base of the metatarsal bone of the great toe. *Use;* it extends the foot and inclines the sole outwards.

Fig. 74.

Fig. 75.

Peroneus Brevis.[8] — *Origin*, from the lower two-thirds of the outer surface of the fibula. *Insertion*, into the base of the metatarsal bone of the little toe. *Use;* it extends the foot.

Gastrocnemius. — *Origin*, by two heads from the condyles of the femur. *Insertion*, by the *tendo Achillis* into the tuberosity of the os calcis

Soleus.—*Origin*, from the upper two-thirds of the posterior part of the fibula, and the middle third of the tibia. *Insertion*, into the *tendo Achillis.*

These last two muscles form the calf of the leg, and are called the triceps suræ.

Plantaris.—This muscle has the longest tendon in the body. *Origin*, just above the external condyle of the femur. *Insertion*, into the os calcis before the *tendo Achillis.*

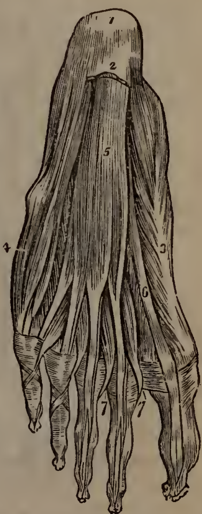
Popliteus[6] (Fig. 75).—*Origin*, from behind the external condyle of the femur. *Insertion*, into an oblique ridge of the tibia, below its head. *Use;* it bends the leg and rolls it inwards.

Flexor Longus Digitorum Pedis Perforans.[7]—*Origin*, from the back of the tibia below its oblique ridge. *Insertion*, into the bases of the third phalanges of the four lesser toes, by four tendons, which perforate the split tendons of the flexor brevis. *Use;* it flexes the toes and extends the leg.

Flexor Longus Pollicis Pedis.[9]—*Origin*, from the lower two-thirds of the posterior face of the fibula. *Insertion*, into the second phalanx of the great toe. Its tendon is connected with the flexor longus digitorum pedis. *Use;* it flexes the great toe.

Tibialis Posticus.[8]—*Origin*, by two heads from the tibia and fibula, and from the interosseous ligament. *Insertion*, into the tuberosity of the scaphoid bone. *Use;* it extends the foot.

Fig. 76.



MUSCLES OF THE FOOT.

Extensor Brevis Digitorum Pedis[11] (Fig. 74).—*Origin*, from the greater apophysis of the os calcis. *Insertion*, by four tendons into the backs of the four greater toes. *Use;* it extends the toes.

Flexor Brevis Digitorum Pedis[5] (Fig. 76.)—*Origin*, from the larger tuberosity of the os calcis and plantar fascia. *Insertion*, by four small tendons, which are perforated by those of the flexor longus, into the second phalanges of the four smaller toes.

Flexor Accessorius.—*Origin*, from the inside of the sinuosity of the os calcis in front of its tuberosities. *Insertion*, into the outside of the tendon of the flexor longus, at its division. *Use;* it assists in flexion.

Lumbricales Pedis.[7]—*Origin*, from the tendons of the flexor longus. *Insertion*, into the inside of the first phalanx of each toe. *Use;* they assist in flexion.

Abductor Pollicis Pedis.[3]—*Origin*, from the internal tuberosity of

the os calcis, the plantar fascia, and internal cuneiform bone. *Insertion*, into the inner side of the base of the first phalanx of the great toe, including the internal sesamoid bone. *Use;* it draws this toe from the others.

Flexor Brevis Pollicis Pedis.—It consists of two bellies, which *arise* from the calcaneo-cuboid ligament and external cuneiform bone. *Insertion*, by two tendons into the base of the first phalanx of the great toe, including the sesamoid bones. *Use;* it flexes this toe.

Adductor Pollicis Pedis.—*Origin*, from the calcaneo-cuboid ligament, from the bases of the third and fourth and fifth metatarsal bones. *Insertion*, into the tendon of the flexor brevis and external sesamoid bone. *Use;* to draw this toe towards the rest.

Abductor Minimi Digiti Pedis.[4]—*Origin*, from the outer and lesser tuberosity of the os calcis and the metatarsal bone of the little toe. *Insertion*, into the base of the first phalanx of the little toe. *Use;* it draws this toe from the others.

Flexor Brevis Minimi Digiti Pedis.—*Origin*, from the calcaneo-cuboid ligament, and from the fifth metatarsal bone. *Insertion*, into the base of the first phalanx of the little toe. *Use;* it bends the little toe.

Transversalis Pedis.—*Origin*, from the capsular ligaments of the

Fig. 77.

Fig. 78.

first joint of the fourth and fifth toes. *Insertion*, into the external sesamoid bone. *Use;* it approximates the heads of the metatarsal bones.

Interosseous Muscles.—These are seven in number, four of which are

upon the dorsal, and three upon the plantar surface of the foot. The *dorsal interossei*,[1,2,3,4] arise by double heads, and are inserted into the bases of the phalanges. The first is inserted on the inner side of the second toe, and is therefore an adductor; the other three are inserted into the outer side of the second, third, and fourth toes, and are abductors. The *plantar interossei*[1,2,3] arise from the bases of the three outer metatarsal bones, and are inserted into the inner side of the bases of the first phalanges of the same toes. In their action they are abductors.

SECTION IV.

VISCERA.

ORGANS OF DIGESTION.

MOUTH.

THE *Mouth* is separated from the nose by the hard and soft palate, and communicates behind with the fauces. It is bounded in front by the lips, while its floor is formed by the mylo-hyoid muscles, and its sides by the cheeks. The space between the lips and the teeth is called the *vestibule.* The mouth is lined by a mucous membrane, which has a variable degree of thickness, and is thrown into folds, which are called *frena;* there is one beneath the tongue, one in front of the epiglottis cartilage at the root of the tongue, and one at the middle of the inner surface of each of the lips. This membrane is covered with numerous glands, some of which are mucous and some salivary.

Internally the lips are composed of muscular fibres, which extend from the middle of the internal surface of each lip to the gum, of fat, and externally of skin. The *upper lip* is longer and thicker than the lower, and has a vertical depression on the middle of its front surface called *philtrum.*

The *Gums* are formed of the lining membrane of the mouth, much thickened; they have great hardness and vascularity, and but little sensibility in health. They include the neck of the tooth, and adhere firmly to the periosteum.

The gums and lips are covered by numerous papillæ, which consist of capillaries and nerves.

The cheeks are composed of muscle, fat, cellular tissue, glands, and blood-vessels, included between skin and mucous membrane.

TONGUE.

The *Tongue* is an oblong, flattened, muscular body, which varies in size and shape; it is the organ of taste, and also of importance in

speech and mastication. Its posterior extremity or root is attached to the hyoid bone by yellow fibrous tissue. Its anterior extremity is called its point or *tip;* its intervening portion its *body.*

The *mucous covering* of the tongue is very thick upon its upper surface, and very thin upon its under surface. Sometimes the term periglottis is applied to the epithelium of the upper surface. Upon its upper surface are a number of projections or *papillæ* of various sizes and shapes. The largest are eight or nine in number, called papillæ *maximæ,* and are situated at the posterior portion of the tongue, in two convergent lines; they are surrounded by fossæ, the largest of which is in the middle, and called the *foramen cæcum.* These larger papillæ will be found to be covered by smaller ones, which are called secondary papillæ. The smallest papillæ are fine and pointed, and are found near the middle of the tongue, and are termed *filiform.* The intermediate papillæ are most abundant, some of them are *conical,* others *fungiform.* Each papilla is formed of capillary vessels and a nerve. Different functions are attributed to these different papillæ.

Fig. 79.

Between the papillæ maximæ and the epiglottis are a number of large mucous follicles.

Muscles of the Tongue.—Hyo-glossus.[4]—*Origin,* from the cornu of the hyoid bone.[2] *Insertion,* into the side of the tongue, some of the fibres reaching its tip. (Fig. 80.)

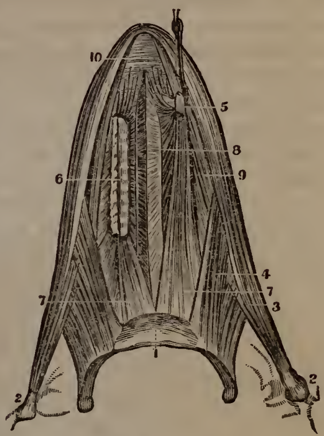
Genio-hyo-glossus.[5]— *Origin,* by a tubercle behind the symphysis of the lower jaw. *Insertion,* into the hyoid bone, and into the whole length of the tongue.

Lingualis.[9]— *Origin,* from the yellow tissue at the root of the tongue. *Insertion,* into the tip between the two last-mentioned muscles.

Superficialis linguæ.—An indistinct layer of muscular fibres on the dorsum of the tongue under the mucous membrane. It seems to curl the lip upwards.

Transversales linguæ.[10] — Are scattered fibres which pass from the middle line to the edge of the tongue; they extend from the tip to the root, and their contractions lengthen the tongue.

Fig. 80.



Verticales linguæ.[3]— These are fibres which extend from the upper to the lower surface of the tongue.

The tongue is supplied by the lingual artery.

The nerves are the hypoglossal or 9th, which is distributed to its muscles; the lingual or *gustatory* branch of the 5th, which supplies the papillæ and mucous membrane at the forepart and sides of the tongue; and the lingual branch of the glosso-pharyngeal division of the 8th, which sends filaments to the papillæ maximæ, and to the mucous membrane near the base of the tongue.

THE PALATE.

The palate separates the back portion of the nose from the mouth, and is divided into two parts. The *hard palate* consists of the palate processes of the superior maxillary and palate bones, covered by mucous membrane, which is continuous with that of the mouth, but is not so vascular or sensitive as that of other parts. It very frequently presents transverse ridges, as well as a ridge in the median line. The *soft palate* is the membranous separation between the back portion of the mouth and nose, and consists of a fold of mucous membranes stretched transversely, enclosing muscles and glands. From its middle there projects the *uvula*, about three quarters of an inch in length; from each side of the uvula there are two divergent crescentic folds of mucous membrane, which are called *lateral half-arches;* the space between which constitutes the *fauces*.

Between the anterior and posterior arches of each side is the *tonsil gland.* The *tonsil* is about the size of an almond, and consists of a collection of large mucous follicles.

Muscles of the palate.— Constrictor isthmi faucium.—A small muscle placed in each anterior half-arch, *arising* from the middle of the soft palate, and *inserted* into the side of the root of the tongue. It diminishes the opening into the pharynx.

Palato-pharyngeus.—Another small muscle, included in the posterior half-arch, arising from the soft palate, and *inserted* into the side of the pharynx. It draws the palate down and the pharynx up.

Circumflexus or *Tensor palati.*—*Origin,* from the spinous process of the sphenoid bone, and the contiguous portion of the Eustachian tube. *Insertion,* by a tendon, which winds around the hamulus or hook of the internal pterygoid process, into the posterior and crescentic edge of the palate. *Use;* to extend the soft palate transversely.

Levator palati.—*Origin,* from the petrous portion of temporal bone and Eustachian tube. *Insertion,* into the soft palate. *Use;* it draws the palate upwards.

Azygos uvulæ.—Is in the middle of the uvula and soft palate. It arises from the posterior nasal spine. Its contractions shorten the uvula.

SALIVARY GLANDS OF THE MOUTH.

The salivary glands are of a light pink colour, and their secretion is of great service in mastication and digestion. They are three in number—the parotid, submaxillary, and sublingual.

Fig. 81.

The *parotid*[1] is the largest of the three; its shape is irregular; it has no capsule, and is merely covered by the superficial fascia of the neck. It lies on the side of the face in front of the ear, and beneath the skin. It extends in front, so as to cover a portion of the masseter muscle; in depth it reaches towards the styloid process, and posteriorly it is bounded by the external meatus, the mastoid process, and the sterno-cleido-mastoid muscle. Its structure is lobulated, and its duct, called the *duct of Steno,*[2] traverses the outer face of the masseter muscle in a line drawn from the lobe of the ear to the end of the nose. It is white and hard, about the size of a crow-quill, and perforates the cheek through a pad of fat by a very small orifice opposite

the second molar tooth of the upper jaw. The external carotid artery passes through the deeper portion of the gland, and it is also traversed by the portio dura nerve. There is sometimes found in front of the gland an accessory portion, called *socius*, or *accessorius parotidis*, whose duct empties into that of Steno.

The *submaxillary* gland[3] is much smaller than the parotid, is irregularly oblong in figure and lobulated in structure. It is situated in a depression on the internal face of the inferior maxillary bone, and covered externally by the skin, superficial fascia, and platysma muscle. Its duct[4] is called the *duct of Wharton*, which empties at the side of the frænum under the tongue by a very small orifice on the summit of a papilla; the coats of this duct are very thin; the gland is traversed by the facial artery as it mounts the lower jaw. Sometimes there is an additional gland and duct, called after Bartolin.

The *sublingual gland*[5] is the smallest of the three; its shape is also oblong, and its structure lobulated; it is situated under the tongue, between the mucous membrane of the mouth and the mylohyoid muscle. Its duct or ducts (for they are frequently numerous) are called after Rivinus, and empty into or near the duct of Wharton.

THE PHARYNX AND ŒSOPHAGUS.

The *pharynx* is a muscular and membranous sac, communicating with the mouth, nose, œsophagus, larynx, and Eustachian tube. It is situated in front of the vertebral column, and extends from the basilar process of the occiput to the fourth or fifth cervical vertebra. It is funnel-shaped, being larger above than it is below. Its length is about five inches, although this varies by contraction and distension; it is never collapsed, for its walls are always kept distended by its muscular origins. It consists of three coats, *muscular*, *cellular*, and *mucous*. Its external or muscular coat is formed by the following muscles.

The *inferior constrictor muscle*[9] arises from the cricoid and thyroid cartilages. (Fig. 82.) The fibres terminate in those of its fellow along the posterior median line; those of the upper part are oblique, those of the lower horizontal.

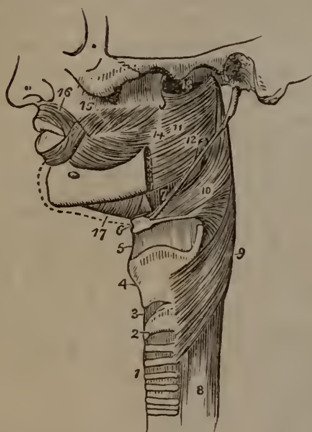
The *middle constrictor muscle*[10] arises from the cornu of the os hyoides, and the lateral thyreo-hyoid ligament, and is inserted into its fellow in the posterior median line. Its upper fibres ascend obliquely to the basilar process of the occiput, and overlap the superior constrictor, while its lower fibres are horizontal or descending, and are overlapped by the inferior constrictor.

The *superior constrictor muscle*[11] is quadrilateral, arising from the pterygoid process of the sphenoid bone, from the upper and lower jaw, the buccinator muscles, and the root of the tongue: it is inserted into its fellow behind, and also into the basilar process of the occiput.

The *stylo-pharyngeus muscle*[12] has been described before.

The *cellular* coat is thin, and merely serves for the transmission of vessels and nerves, and the connexion of the external and internal coats.

Fig. 82.



The *internal* or *mucous coat* is a continuation of that of the mouth, nose, and Eustachian tube, and it is covered by a thin epithelium, and studded with mucous follicles and glands. It is supplied by the pharyngeal and palatine arteries, and by the sympathetic and eighth pair of nerves. Its uses are for deglutition, respiration, and modulation of the voice.

The *œsophagus* is a canal which conveys the food from the pharynx to the stomach. It is situated in the median line, in front of the vertebral column, and passing through the posterior mediastinum inclines somewhat to the left side at its lower part, where it passes through the diaphragm.

Its length is about nine or ten inches, and its diameter is not uniform, gradually increasing as it descends. Its upper portion is the narrowest part of the alimentary canal, and hence foreign bodies which are too large to pass through the alimentary canal, are generally arrested in the neck; its shape is cylindrical, although its walls when at rest are in contact. It never contains air.

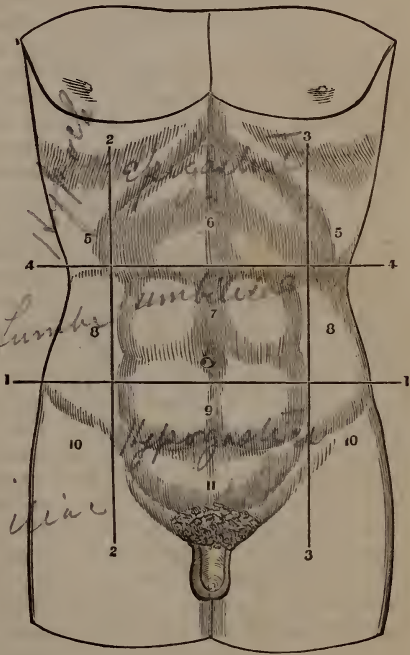
It has three coats, the external of which is muscular, and thicker than any other portion of the canal. The muscular coat consists of two layers; the fibres of the external are longitudinal, and those of the internal are circular. The *cellular* coat attaches the muscular and mucous, and serves for the passage of vessels and nerves. The *internal* or *mucous* coat is continuous with that of the pharynx, and has a number of longitudinal folds when in a state of quiet. It has a thick epithelium, and numerous mucous glands and follicles. It is supplied by the œsophageal arteries, proceeding from the inferior thyroid, aorta, coronary, and phrenic arteries; its nerves are derived from the eighth pair, and from the sympathetic.

Deglutition is performed by the contraction of its longitudinal fibres, which shorten the passage, and by the contraction of its circular fibres successively from above downwards.

VISCERA OF THE ABDOMEN.

The cavity of the abdomen is divided into nine different regions, by the drawing of parallel lines vertically[2,3] through the anterior inferior spinous processes, and intersecting them with two other parallel lines drawn transversely[1,4] over the crests of the ilia, and over the most prominent part of the costal cartilages. We thus have three regions above, three in the middle, and three below.

Fig. 83.



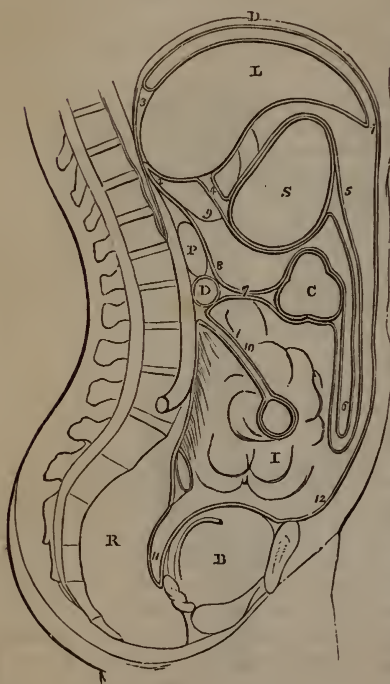
They are the *epigastric*,[6] in which are the left lobe of the liver, and a portion of the stomach; the *right hypochondriac*,[5] containing within it the right lobe of the liver, the *left hypochondriac*,[5] containing the spleen, a portion of the stomach, and the liver; the *umbilical*,[7] in which are the small intestines, and on either side the *lumbar* regions;[8] the *right lumbar* region contains the right kidney, and ascending colon; while the *left* contains the left kidney and descending colon; the *hypogastric* region,[9, 11] in which is a portion of the small intestines and bladder; and the *iliac fossæ*;[10] the *right* of which contains the cæcum or caput coli, and the *left* contains the sigmoid flexure.

PERITONEUM.

The peritoneum is a thin, transparent membrane, lining the cavity of the abdomen, and covering most of the viscera that are contained therein. It is a serous membrane, and therefore a shut sac, following the general rule of lining the cavity, and covering the organs contained within. It secretes a small quantity of fluid in health, which lubricates the surfaces of the viscera, so that they readily move upon each

other and the walls of the cavity. It also forms ligaments and connexions by which the viscera are held in their places. That portion of the peritoneum which passes between one viscus and another, or from a viscus and the wall of the cavity, usually consists of two laminæ, and is called an *omentum*. There are four principal omenta, viz., the *gastro-hepatic* or *lesser omentum*, which reaches from the lesser curvature of the stomach to the liver; the *gastro-splenic*, reaching from the left extremity of the stomach to the spleen; the *colic-omentum* or *meso-colon*, which holds the large intestine to the posterior wall of the abdomen; and lastly, the *gastro-colic* or *great omentum* or *caul*, which passes between the stomach and colon; the last is the largest, and covers the intestines like an apron; it appears to consist of four layers, whereas, like the rest, it consists but of two. Owing to its great size and the proximity of the colon to the stomach, it must necessarily be folded or doubled, and thus presents a quadruple appearance.

Fig. 84.



Since the peritoneum is a continuous membrane, its whole surface can be traced in a male subject with the point of a finger, otherwise it would not be a single sac. In the female there is a deficiency at the extremity of the Fallopian tube.

Commencing at the umbilicus to trace the peritoneum, it will be found to line the anterior wall of the abdomen and under surface of the diaphragm, thence to cover the upper and a part of the lower surface of the liver,[L] thence to pass to the stomach,[S] forming thus[4] the upper lamina of the gastro-hepatic or lesser omentum; having covered the anterior face of the stomach,[S 5] it passes down to form one of the laminæ of the apparently quadruple omentum — the gastro-colic; ascending again it forms another lamina, and surrounding the inferior semi-circumference of the colon,[C] it passes to the vertebral column, forming the inferior lamina of the colic omentum,[7] then we find it in-

cluding the small intestine forming at the mesentery;[10] from the vertebral column it can be traced over the upper and anterior part of the rectum,[R] and over the posterior and superior portion of the bladder,[B] forming at the vesico-rectal pouch,[11] and again we trace it to the umbilicus, the point whence we started.

But in thus tracing it will be found, by the diagram, that we have not traced the peritoneum covering some portions of the viscera and abdomen. In the dead subject it is very easy to introduce the finger through a narrow passage which is called the *foramen of Winslow,* although there is no hole or tearing of the peritoneum. By looking for the posterior end of the gall-bladder and passing the finger under the vessels of the liver, it will be easy to touch the peritoneum covering the posterior surface of the stomach. This cannot be demonstrated very clearly from a drawing alone, which represents merely a longitudinal section of the abdominal cavity; and without explanation it gives the false idea of there being two sacs instead of one. In the subject, however, by placing the finger upon the under surface of the liver, we trace the peritoneum through the foramen of Winslow; there it forms the inferior lamina of the lesser omentum,[4] thence it covers the inferior surface of the stomach; descending it forms the third and ascending at [6], it forms the fourth lamina of the great omentum; then it covers the superior convexity of the colon, and forming the superior lamina of the colic omentum at [7], it ascends in front of the duodenum and pancreas, [P D] and passing out at the foramen of Winslow, we can trace upon the posterior and inferior portion of the liver, the point of starting.

The *mesentery*[10] is formed of two laminæ of peritoneum, serving to connect the small intestine to the parietes of the abdomen. Its root is about six inches wide, and its inferior edge equals in breadth the whole length of the small intestine. Between these two laminæ of peritoneum are the superior mesenteric artery and vein, lymphatic glands and vessels, and branches of the sympathetic nerve, together with a portion of fat and cellular tissue.

The *meso-colon*[7] is also formed of two laminæ of peritoneum, and holds the large intestine in its place. The transverse portion is long and loose, but on each side in the iliac regions it is short, and binds the intestine down very tightly; it also contains between its laminæ, vessels and nerves, together with some fat and cellular tissue; that portion which is attached to the rectum is called the *meso-rectum.*

THE STOMACH.

The stomach is a conoidal sac, somewhat bent or curved, and is situated in the left hypochondriac and epigastric regions. It is somewhat flattened anteriorly and posteriorly, and thus presents an anterior and posterior face; its direction is oblique from above downwards, and from left to right. The left[3] extremity is much the larger, and

terminates in a rounded cul-de-sac; at the superior portions of this extremity is the *cardiac* orifice,[2] where the œsophagus is continued into the stomach immediately below the diaphragm. The right extremity gradually diminishes in size, and its orifice is called *pyloric*,[9] which is continuous with the small intestine. The structure of the pylorus is much thicker than that of any other portion.

The stomach is held in its position by the œsophagus[1] and the duodenum,[10] as well as by peritoneal reflexions. The right end is lower and more anterior than the left.

The upper and lower curvatures of the stomach are called the greater and lesser curvatures.[5 6] Near the pyloric extremity of the stomach, is a slight dilatation[7] called *antrum pylori.* The dimensions of the stomach are variable, depending upon the mode of life. It consists of four coats; peritoneal, muscular, cellular, and mucous.

Fig. 85.

The walls of the stomach consist of four distinct coats.

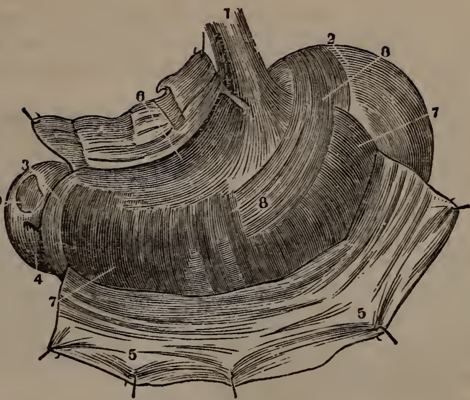
The *Serous* or *Peritoneal coat* completely covers the stomach, except at the curvatures, where are attached the omenta; the looseness of the omental connections at these points admits of the distension of the remaining coats.

The *Muscular coat* is not so thick as that of the œsophagus, and its fibres pass both in a circular,[7] longitudinal,[6] and oblique direction (see Fig. 86). The muscular fibres which pass obliquely round the left extremity, constitute the muscle of Gavard.[8] The circular fibres are most numerous near the pyloric orifice, and the longitudinal fibres are most distinct upon the lesser curvrture. The latter are the most external, and are a continuation of those of the œsophagus.

The *Cellular* or *nervous coat* connects the muscular and mucous; it serves for the transmission of vessels and nerves, and can readily be inflated; when dried, it resembles cotton.

The *Mucous* or *Villous coat*, is a continuation of that of the œsophagus; it is soft and thick, of a light pink colour, and is thrown into a number of longitudinal *rugæ* or folds, which are particularly numerous at the greater curvature, and nearer the pyloric orifice.[8] (See Fig. 86.)

Fig. 86.



At the pyloric orifice, the mucous membrane is thrown into a circular or semicircular fold, which is called the *pyloric valve.*

The *epithelium* of the mucous membrane of the stomach is thinner than that of the œsophagus, and is of the conoidal variety.

The surface of the mucous membrane of the stomach presents different appearances in different portions. These will be best seen by minutely injecting the stomach of a child and washing off the epithelium.

The left extremity and the great body of the stomach will exhibit polygonal *cells* or *alveoli*, which give it a honeycomb appearance.

The walls of these cells or pockets, as well as the ridges between them, are composed of capillaries united by basement membrane. These cells are larger in the cardiac extremity, and very regular in their appearance. The bottom of each cell is subdivided into smaller cells by the arrangement of the capillaries, and these smaller cells are the orifices of the *gastric glands* or tubuli which secrete the gastric juice. Near the antrum pylori the cells or alveoli are less numerous and smaller; and the ridges separating them are larger. Towards the pyloric valve there exist conical projections, which may be termed *gastric villi;* these villi are smaller than those of the intestine.

The lesser curvature is supplied by the gastric artery, the greater by the right and left gastro-epiploics, and the greater extremity by the vasa brevia. The nerves are derived from the par vagum and solar plexus of the sympathetic.

INTESTINES.

The intestinal canal is from thirty to thirty-five feet in length, and is divided into *large* and *small intestine.*

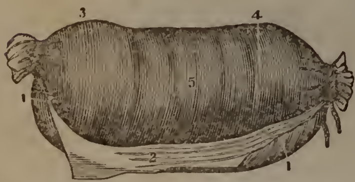
SMALL INTESTINE.

The small intestine is four-fifths of the length of the whole canal, reaching from the pylorus to the large intestine; it is cylindrical, and about one inch in diameter; there is a gradual diminution in diameter as it descends. It consists of four coats.

The *Peritoneal coat*[1] is the external coat, and is continuous with that portion of the peritoneum forming the mesentery.

The *Muscular coat* is thin, and consists of pale fibres; the superficial are longitudinal;[2] the remainder are circular,[3 4] and more distinct.

Fig. 87.



The *Cellular coat* connects the muscular and mucous, and contains the vessels and nerves; when inflated with air and dried, it appears like cotton, as is the case in the stomach.

The *Mucous coat* is continuous with that that of the stomach, and covered with a conoidal epithelium. It is longer than any other coat, and hence must be thrown into numerous folds, which are called *Valvulæ Conniventes;* these are circular and overlapping, and more numerous[2] and larger[1] in the upper portion of the intestine than in the lower. They differ from other folds of mucous membrane in being permanent; distension does not remove them.

The surface of the mucous membrane is covered with a number of papillary projections, called *Villi*, which render it soft and velvety.

Their shape varies in different parts of the intestine; in the upper part of the intestine they are more numerous, and resemble triangular convolutions; in the lower they are more conical and cylindrical. Their length varies from $\frac{1}{4}$th to $\frac{1}{3}$d of a line. Each consists of a capillary network united by single membrane, and communicating with a small artery and vein. They contain also lymphatics (Fig. 88), or lacteals, and a number of granular corpuscles and fat cells. The exterior is covered with a conoidal epithelium.

The *glands* of the small intestine are the crypts or follicles of Lieberkühn, the glands of Peyer, the Solitary Glands, and Brunner's Glands.

The *crypts* are the smallest of the glandular structures, and consist of nothing more than pockets or tubes opening by small orifices in every part of the intestine. (Fig. 89.) Their diameter is $\frac{1}{50}$th of a line. They are lined by epithelium.

The Glands or *Patches of Peyer.*—These are all called *agminate.* They are oval clusters of small, round, flattened vesicles or capsules, often filled with a white semifluid matter, and situated beneath the mucous membrane. When empty of fluid they are difficult of detec-

Fig. 88.

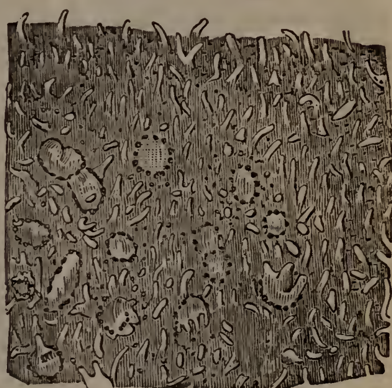
Fig. 89.

tion. Their size varies from half an inch to four inches in length. Occasionally they are nine inches long.

They are more numerous in the lower part of the ileum, opposite the mesenteric attachment. There may be twenty or thirty in each individual.

The *solitary* glands differ from the Agminate or Peyerian only in being separate. They are soft, white, rounded elevations, scattered over the whole surface of the mucous membrane of the small intestine. They frequently contain a white fluid, but like the vesicles of the Peyerian patch, have no orifice of discharge.

Fig. 90.



Brunner's glands are small round bodies in the upper part of the duodenum. They are compound glands, containing lobules and branched ducts, which open upon the intestine.

The mucous membrane of the small intestine is ex-extremely vascular, and its absorbents are very numerous.

The arteries are derived from the superior mesenteric, and the nerves from the solar plexus.

The small intestine is divided into Duodenum, Jejunum, and Ileum.

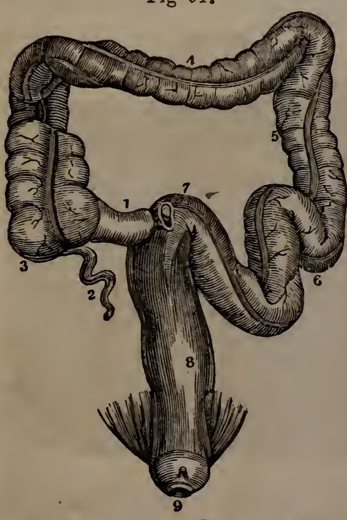
The *Duodenum* commences at the pylorus, and is about twelve inches in length. It is curved in its direction, and partially deficient in its peritoneal coat, on account of its being received between the two laminæ of the colic omentum. Its mucous coat is characterized by its colour, being tinged with bile, and by the great abundance of valvulæ conniventes in its lower part; the upper part contains the glands of Brunner. The *ductus communis choledochus* opens into the duodenum four or five inches from the pylorus, through a small elevation or tubercle.

The *Jejunum* (from jejunus, *empty*), constitutes two-fifths of the small intestine, and the *ileum* the remaining three-fifths. Although there is no anatomical reason for this division, it being impossible, from appearances, to say where the jejunum terminates or the ileum begins, yet if a portion of the upper extremity of the jejunum be compared with a portion of the lower extremity of the ileum, it could be recognised by its diameter, abundance of valvulæ conniventes, and the small number of *Peyer's Glands*. There are frequently *blind pouches*, varying in size from one to two inches, along the course of this small intestine.

LARGE INTESTINE.

The large intestine reaches from the ileum to the anus, and is one-fifth in length of the whole intestinal canal; it differs much from the small intestine in its diameter, and has a sacculated appearance. Like the small intestine, it consists of four coats.

Fig 91.



The *peritoneal coat* is continuous with the meso-colon, and has numerous folds filled with fat, which are called *appendices epiploicæ*.

The *muscular coat* consists of two sets of fibres; the longitudinal fibres are collected into three bands, each about half an inch in breadth, which extend to the rectum; the circular fibres are also thicker than those of the small intestine.

The *cellular coat* connects the mucous and muscular, and contains the blood-vessels and nerves.

The *mucous coat* has no *valvulæ conniventes* nor *villi;* it is whiter,

thicker, and coarser, than that of the small intestine. Its *follicles* or crypts are extremely numerous, and more readily discerned than in the small intestine. They are very regular and uniform in their appearance, and consist of a capillary network, forming a pouch or tube lined by conoidal epithelium. There are also some glands scattered over the mucous coat of the large intestine, which are about half a line in diameter. They consist of a dilated cavity with a narrow orifice.

The epithelium of the large intestine is columnar, and lines the crypts and glands.

The large intestine is divided into the cæcum, colon, and rectum.

The *Cæcum* is a cul-de-sac[3] (Fig. 91), and the commencement of the large intestine, and hence is often called *caput coli.* It is bound down into the right iliac fossa, by the meso-colon; its length varies from one and a half to three inches, and its diameter is greater than that of any other portion of the alimentary canal, except the stomach.

The *appendix vermiformis*,[2] is a worm-like process, of the thickness of a quill, varying in length from three to six inches, and attached to the inferior portion of the cæcum.[3] Its coats are the same as those of the intestine, and it usually contains flatus. Its follicles or crypts are not so numerous or regular in their arrangement and size as those of the other portions of the large intestine, and when injected, show a different arrangement of capillaries.

Fig. 92.

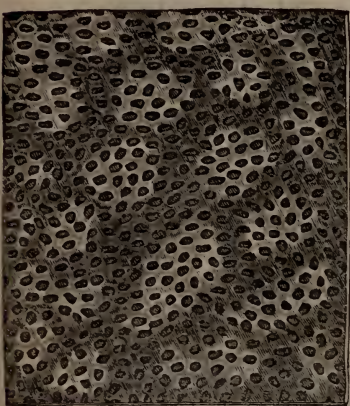


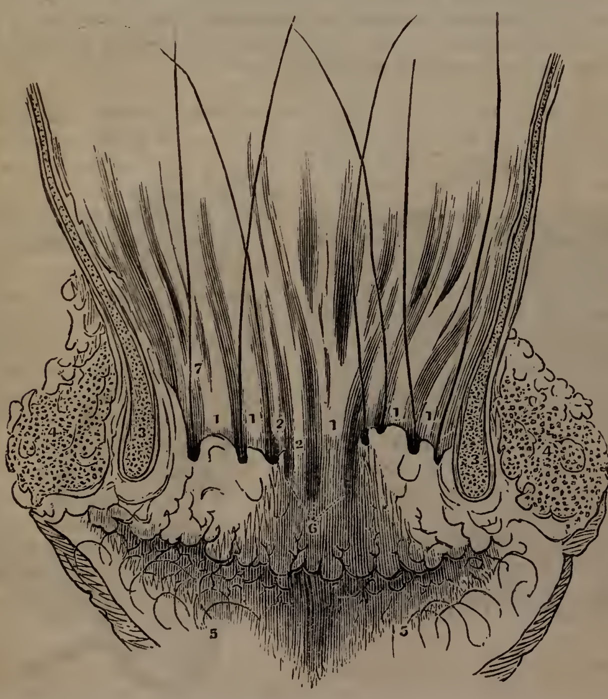
Fig. 93.

The *ileo-cæcal* valve[3] is an elliptical opening on the side of the cæcum, between its circular fibres, whereby the small intestine empties into the large. It is composed of two crescentic folds, the upper of which is the larger. Its action is such that the distension of the cæcum will prevent the passage of air or fluids backwards into the small intestine. (Fig. 93.) It is also called the *valve of Bauhin* or *Morgagni.*

The *Colon* is the longest portion of the large intestine; it gradually diminishes in diameter until it terminates in the sigmoid flexure on the left side.[6] (Fig. 92.) It ascends upon the right side, and forming an arch transversely, descends upon the left. The right side receives its arteries from the superior mesenteric, and the left side receives branches from the inferior mesenteric. The nerves are derived from the inferior and superior mesenteric plexuses of the sympathetic.

The *Rectum* is the terminating portion of the large intestine, and reaches from the sigmoid flexure to the *anus*, occupying a position in

Fig. 94.



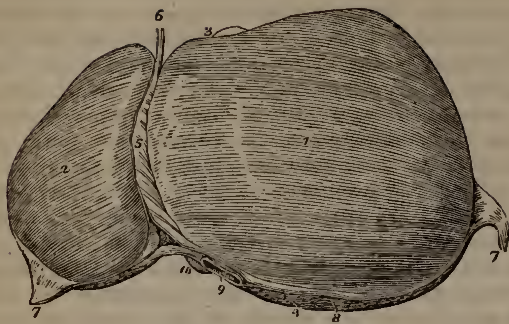
front of the sacrum. It is somewhat barrel-shaped, being larger in the middle than at either end. The *peritoneal* covering is deficient below and behind. The *muscular* coat has a very great *thickness* and redness. The external fibres are *longitudinal*, and the internal *circular*. The fibres of the external muscular coat wind around the inferior edge of the circular coat, and terminate in the mucous coat, which, in some measure, accounts for hæmorrhoids and prolapsus ani. The mucous coat is thicker and redder than in the upper part of the intestine, and at the lower extremity, just above the anus, is thrown into a *number of pouches*[1 2] between the longitudinal muscular fibres. (Fig. 94.) About five or six inches above the anus, is a *semicircular fold* of the mucous membrane on each side of the rectum; these two are about half an inch distant from each other; they resemble the valvulæ conniventes, and in some measure prevent the involuntary discharges of fæces. — The arteries of the rectum are the superior, middle, and inferior hæmorrhoidal. The veins form a plexus around the bowel, which communicates with the internal iliac and portal veins. The nerves are supplied from the sacral plexus, and from the hypogastric plexus of the sympathetic.

THE LIVER (FIG. 95).

The *liver* is the largest glandular organ in the body, and secretes bile. It is oblong and oval in its shape, and occupies the right hypochondriac, a portion of the epigastric, and left hypochondriac regions. It *weighs* from four to five pounds; it *measures* from ten to twelve inches transversely, and from six to seven antero-posteriorly; its greatest thickness is from four to five inches. It is convex upon its upper surface, and concave upon its lower. Its *colour* is of a reddish brown, with occasional spots of black. It is covered almost entirely by peritoneum, which, upon its upper surface, forms a broad *suspensory ligament*,[5] by means of which it is held in contact with the diaphragm. In the anterior edge of this ligament, is another, of a cord-like character, called *ligamentum teres*,[6] which was originally the umbilical vein. It passes through the anterior notch of the liver and umbilical fissure. Posteriorly, the two laminæ of the suspensory ligament diverge, forming the *coronary ligament*, under which the liver is destitute of peritoneum. The *lateral ligaments*[8 8] are also peritoneal, being, in fact, a continuation of the coronary; they are horizontal, and attach the right and left sides of the liver to the posterior walls of the abdomen. There is a deep depression upon the posterior edge of the liver, called the *posterior notch*, whereby the liver is adjusted to the vertebral column. The anterior and posterior notch divide the liver into *two lobes*, the right of which is much the larger and thicker, and the left terminates in a thin cutting edge.

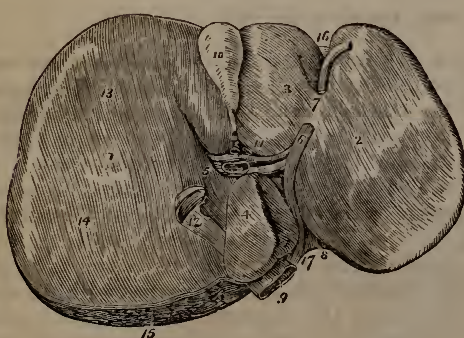
The under surface of the liver presents a deep *fissure*, called *umbilical* or longitudinal, reaching from the anterior[16] (Fig. 96) to the poste-

Fig. 95.



rior[17] notch, and contains the remains of the umbilical vein, now the ligamentum teres, and the remains of the ductus venosus. Sometimes this fissure is converted into a foramen,[7] the right and left lobes being connected. At right angles to this fissure is another, called the *transverse fissure*,[11] which contains the portal vein, hepatic artery, and hepatic duct, bound together by cellular tissue, which is called the *capsule of Glisson*. A deep depression

Fig. 96.



upon the under surface of the right lobe of the liver, parallel with the longitudinal fissure, contains the gall-bladder;[10] that portion of the liver included between this depression and the longitudinal and transverse fissures is called the *lobulus quadratus*,[3] or quartus, from its shape. The *lobulus Spigelii*[4] is a small triangular lobe, at the posterior and inferior portion of the liver, and with the lobulus quadratus, constitutes the *porta* or gateway of the liver. An elongated ridge, running from the lobulus Spigelii outwardly,[5] is called the *lobulus caudatus;* in the angle between the lobulus Spigelii and the right lobe of the liver, is a *deep fissure*, for the passage of the ascending vena cava.[2]

There are *four* sets of *vessels* for the liver.

The *hepatic artery* is a branch of the cœliac, approaches the liver

at the transverse fissure, and divides into two or three large branches previous to entering it.

The *portal vein* collects the blood from all the chylopoietic viscera, and upon reaching the transverse fissure, divides into two large branches, called the *right* and *left sinuses.*

The *hepatic duct*, commencing by fine branches in the interior of the liver, is about the size of a small quill, and is also included with the two last vessels by the capsule of Glisson in the transverse fissure.

The *hepatic veins* commence also by capillaries in the liver. The branches collect and form three large trunks, whose course is backwards towards the posterior notch of the liver. These trunks appear more like channels lined by a thin venous coat, than the ordinary veins. They empty into the ascending vena cava, as it is passing through the fissure formed between the lobulus Spigelii and the right lobe.

The *structure* is best exhibited by tearing the liver; this shows a granulated arrangement, and each of these granules is usually called an acinus. Each acinus consists of a terminal branch of the portal vein and hepatic artery, together with the incipient radicles of the hepatic duct and hepatic vein; and in the capillary rete thus constituted are numerous cells, which secrete the bile. (See Physiology.)

A diversity of opinion exists as to whether these cells are inside or outside of the primitive biliary vessels. It is also doubtful whether the biliary vessels commence by a rete in each acinus, or whether they commence by straight tubes, running between the acini, which, coalescing, form the hepatic duct. The aggregation of these acini is by means of cellular tissue, called the *parenchyma*, which may be considered as a continuation of Glisson's capsule.

Fig. 97.

GALL-BLADDER.

It is placed on the under surface of the right lobe of the liver, and inclines somewhat to the right side. It is a pyriform sac, of about three inches in length; its anterior extremity is globular, and called the *fundus;* its posterior end, or *neck*, is narrow, and twisted like a screw. It consists of *three coats.* The external is formed of the peritoneum,[1] and is only a partial covering for its infe-

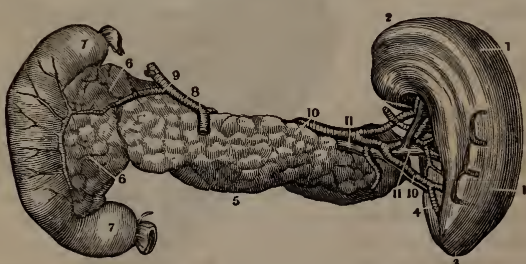
rior surface; the middle[2] consists of a strong layer of fibrous tissue; and the internal is mucous,[3] with short, irregular folds, giving it a fine net-like appearance; its colour is usually that of the bile; in the *neck* it is spirally twisted, and thus acts as a valve. Its duct, called the *cystic* duct is shorter and thinner than the hepatic duct, which it joins at a very acute angle; this junction forms the *ductus communis choledochus*, which is about the size of a goose-quill, and three inches in length. It passes through the right extremity of the pancreas at its posterior portion, and perforates the duodenum obliquely and with a very small orifice, through an elevated tubercle. Its artery, called *cystic*, is a branch of the hepatic.

PANCREAS.

This is a long and flat gland, and of a light pink *colour*. It is *placed* transversely behind the stomach, and in front of the last dorsal and first lumbar vertebræ. It has no peritoneal covering, but is included between the two laminæ of the meso-colon, and extends from the curvature of the duodenum[7] across to the spleen.[1] It is about seven inches long. Its right extremity,[6] or *head*, is much the thickest part, is traversed by the ductus choledochus, and often called the *lesser pancreas*. Its left extremity gradually diminishes in breadth until it touches the spleen.

The superior edge of the pancreas has a *groove* for the passage of the splenic artery.[8 9 10] Its *structure*, like that of salivary glands, is conglomerate. Its excretory *duct*, called after *Wirsungius*, is formed

Fig. 98.



by a collection of small branches, which come from the lobules of the gland. The walls of the duct are thin, white, and smooth, gradually increasing in size. It discharges into the duodenum, generally by means of the ductus communis choledochus. Sometimes it has a separate duct near the latter. The arteries are branches of the splenic.

SPLEEN.

The spleen (Fig. 98[2 1 3]) is in the left hypochondriac region. It is a soft vascular organ of a purplish colour. It has no duct, and it is therefore not a true gland.

The shape of the spleen is irregular and variable, but it is generally a section of an ovoid, with a convex surface resting against the diaphragm, opposite the ninth, tenth, and eleventh ribs, and a concave surface directed towards the stomach; this surface is divided longitudinally by a fissure or hilum, which transmits the blood-vessels.

It is covered by the peritoneum, which appears wrinkled when the spleen is bent. Reflections of the peritoneum from the stomach and diaphragm, called gastro-splenic and splenico-phrenic omenta, hold the spleen in its position. The edges of the spleen are frequently notched, and occasionally small additional spleens are found connected with it.

It varies in size more than any other organ in the body. It is generally five inches long and three wide, and weighs from five to seven ounces. Besides its peritoneal coat, it is covered by an internal elastic tunic, which is of a white colour, and composed of cellular tissue. In some animals muscular fibres are found in this coat. From this tunic are prolonged numerous bands, which traverse the organ in all directions. In the interstices of these bands or trabeculæ the vessels ramify.

The proper substance of the spleen is a soft pulpy mass, of a reddish brown colour, resembling grumous blood, contained between the trabeculæ and outside of the venous plexus. It consists of rounded granules, about the size of the blood corpuscles. Besides these, there are the corpuscles of Malpighi, which are white capsules, varying in diameter from the $\frac{1}{25}$th to $\frac{1}{60}$th of an inch. They contain a soft, white, semifluid matter, which is composed of granules, resembling in size the red corpuscles of the spleen. The lymphatics of the spleen are very numerous.

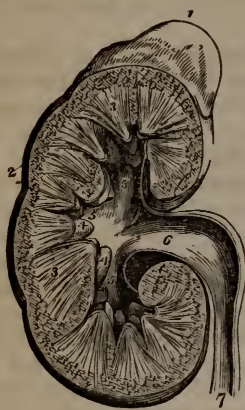
The *splenic artery* is the largest branch of the cœliac, and divides into four or five branches before it enters the spleen. The splenic vein empties into the portal vein.

KIDNEYS (FIG. 99).

The kidneys are two hard glands for the secretion of urine, placed in each lumbar region, and reaching from the first to the third lumbar vertebræ; they are outside of the peritoneal cavity, and surrounded with an abundance of fat and loose cellular tissue. The *right kidney* is rather lower than the left, on account of superposition of the liver. The *length* is four inches, and the breadth two inches. The *shape* is oval, resembling a bean; the position is upright, and the *fissure* or *hilum* is directed inwards towards the vertebral column. The upper

end of the kidney is rather larger than the lower. It is covered by a strong *fibrous capsule*. The *colour* is of a reddish brown. Upon making a longitudinal section of the kidney, *two* different *structures* are presented. The *internal* is of the darker colour, and consists of about fifteen cones of Malpighi, which are arranged in three rows, their apices converging towards the hilum. These constitute the *medullary* portion. The *external* structure is of a lighter colour usually, is extremely vascular, and of a granulated arrangement: it constitutes the *cortical* portion.

Fig. 99.



The *cortical* substance[2] consists of a number of *tortuous tubes of Ferrein*, in which the urine is first formed, and between whose walls are a number of small bodies, called the *corpuscles of Malpighi*.

Mr. Bowman says that the end of each tube is dilated and receives the Malpighian bodies. These bodies are a tuft of capillaries, of about $\frac{1}{120}$th of an inch in diameter. They are supplied by a small artery, and from them emerges a vein, which afterwards forms a rete upon the uriniferous tubes.

The *medullary* cone of Malpighi[3] is capable of subdivision into small *pyramids of Ferrein*, and each pyramid of Ferrein will be found to consist of a number of straight *tubes of Bellini*, which are the continuations of the tortuous tubes of Ferrein.

The apex of each cone is called *papilla renalis*, and in the centre of each papilla is a slight depression, called *foveola*.

Each papilla is surrounded by a small membranous cup, called *infundibulum*,[4] into which the urine is first received as it oozes from the orifices of the papillæ. Four or five of these infundibula join to form a common trunk, called *calyx*,[5] and the junction of about three calyces form a common cavity, called the *pelvis*,[6] which is of a conoidal shape, and from which proceeds the *ureter*,[7] the excretory tube of the kidney, which conveys the urine to the bladder.

The *ureter*[3] is a cylindrical tube of the size of a quill, with thin, white, extensible walls. Crossing in its descent the iliac artery, it enters the inferior fundus of the bladder very obliquely, and opens by a very small orifice. It consists of two coats, the external of which is fibrous, and the internal is mucous The structure of the calyces and infundibula is the same.

SUPRA-RENAL CAPSULES.

The *capsulæ renales*[1] (Fig. 99), are two small bodies, varying much

in size, placed one on each side, just above the kidney, and reposing on its upper extremity. They are of a light brown colour, and surrounded by condensed cellular tissue. In fœtal and youthful life they are much larger than in adult life, and hence it is supposed that the use is confined to that period of life, as in the case of the thymus gland. They are of a triangular or semicircular shape, the base being excavated where it is adjusted to the kidney. Having no secretion, they of course have no duct.

Microscopically they consist of cells and capillaries.

They are supplied by the *capsular* artery, a branch of the renal artery or the aorta.

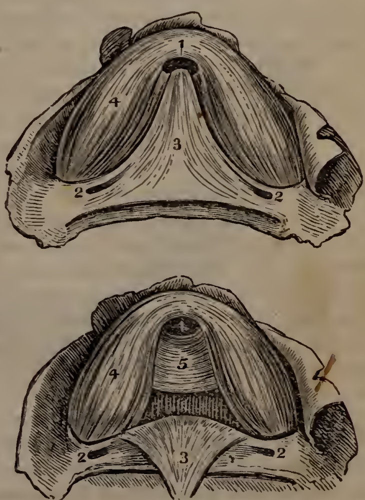
WOLFFIAN BODIES.

These structures exist only until the sixth month of fœtal life. Before this period they conceal the kidney and renal capsule. They consist of tubes which empty into the sinus uro-genitalis, a duct peculiar to fœtal life.

BLADDER.

The bladder is a musculo-membranous sac for the reception of urine. It is situated in the cavity of the pelvis, behind the symphysis pubis, and in front of the rectum, in the male; but in the female, the uterus and vagina are between the bladder and rectum. It is connected with the umbilicus by means of a kind of ligament, called the *urachus.*[1] (Fig. 101.)

Fig. 100.



Its *shape* is oval, the larger end being downwards; in women it is more spheroidal; in children it is pyriform. It is divided into a superior and inferior *fundus*, a *body* and *neck*.

Its *dimensions* vary with health and disease. An ordinary healthy bladder will hold nearly a pint. The *round ligaments* of the bladder were formerly the umbilical arteries, and are contained in folds of peritoneum on each side of the superior fundus; besides which the bladder is held in its place by the *anterior* and *lateral* ligaments, which are processes of the pelvic fascia.

The bladder has four coats, viz., the *peritoneal*, which only

covers the posterior part of the body and superior fundus. The *muscular* coat is thicker than that of the intestine; the fibres are pale and unstriped. The external fibres are more longitudinal, and the internal more transverse or circular in their course, and pass in various directions. The *cellular* coat is thick and dense, very distensible and impervious to water. It connects the muscular and mucous coats and transmits the vessels and nerves. The *mucous* coat is soft, smooth, and of a light pink colour. It is covered by an epithelium. It has numerous follicles, which are exceedingly small. The *vesical triangle* is a space within the cavity of the bladder, and included between the two orifices of the ureters[2] and the orifice of the urethra. In the anterior angle there projects in the bladder the *uvula vesicæ,* a prominence of the third lobe of the prostate, covered by the mucous membrane. Under the mucous membrane of the vesical triangle is a plane of fibres,[3] connected with the orifice of the ureters,[2] and that of the ductus ejaculatorius. Surrounding the neck of the bladder is the *sphincter vesicæ*, which consists of a semi-circular[4] and a transverse[5] set of fibres.[1] The latter are partly composed of yellow elastic fibres. (Fig. 100.)

PENIS.

The penis conveys the urine from the bladder, and the semen into the female. The anterior extremity or head is the *glans,*[17] the posterior extremity is the *root,*[15] and the intervening part is the *body,* which consists of two structures, the *corpus cavernosum* and *corpus spongiosum.*

Fig. 101.

The skin of the penis is thin and delicate, and has numerous hairs and sebaceous follicles. Surrounding the glans is a loose doubling of skin called the *prepuce*, which is connected to the orifice of the urethra by a vertical process called the *frænum.*

The glans has a thick rim or edge around its base, the *corona* glandis, behind which the penis is narrow, and this portion is known as the *neck* or *collum*. The *glands of Tyson* are the sebaceous follicles, numerous about the *neck* and *crown*, and whose secretion is called *smegma*.

Beneath the skin is the *fascia* of the penis, which is formed of condensed cellular tissue, and is in fact a continuation and modification of the superficial fascia of the abdomen. That portion of the fascia which passes from the pubes to the penis is the *ligamentum suspensorium*, which is triangular in shape and vertical in position, and antero-posterior in direction. The fascia of the penis may be said to be formed by the penis being included between two laminæ of this ligament.

The *corpus cavernosum*[14] forms the largest part of the penis, and is in shape a double cylinder. At the root these cylinders are separate and pointed, and called the *crura*[15] of the penis. Each crus is firmly attached to the ramus of the pubes and ischium, constituting the origin of the penis. *Externally* the corpus cavernosum is covered by a dense, thick, fibrous, and elastic coat. *Internally* it consists of a spongy structure made up of cells, which readily communicate with the arteries and veins. There are some arteries which do not terminate, however, in these cells, but in blind tufts, called *helicine arteries*. The two cylinders are partially separated from each other by the *septum pectiniforme*, a partition which is more complete behind than before, and whose fibres being vertical, somewhat resemble the teeth of a comb, whence the name.

The *corpus spongiosum*[20] occupies the same position with relation to the corpus cavernosum, as a ramrod does to a double-barrelled gun; being contained in a longitudinal groove on its inferior surface, the nutritious vessels occupying a corresponding position above. It is covered by a dense fibrous covering also, but it is thinner than that of the corpus cavernosum. *Internally* it is composed of cells, which are larger than those of the corpus cavernosum.

Posteriorly it reaches the triangular ligament; this extremity is enlarged into what is called the *bulb*,[21] which lies between the divergent crura of the penis; anteriorly it forms the glans penis.[17]

The *urethra*[6, 12, 13] is the urinary canal from the bladder, and perforates the corpus spongiosum. It consists of two coats; the external is formed of yellow elastic tissue, and a few involuntary muscular fibres; the internal is mucous, and continuous with that of the bladder. The course of the urethra is curved and its diameter varies.

The first part perforates the upper part of the prostate gland, and is termed the *prostatic portion*;[6] this is an inch in length, and in it we find the *uvula vesica* behind and looking into the bladder; and a triangular elevation of mucous membrane in front, called the *caput gallinaginis* or *verumontanum*. In front of the caput gallinaginis is the *utriculus*, or *sinus pocularis*, a small pocket into which empty the

ejaculatory ducts.[8] On each side there is a groove perforated with the orifices of the *prostatic ducts.*[7]

The next portion is the *membranous;*[10] this is eight or ten lines in length and is very narrow; it perforates the triangular ligament, and it is surrounded by loose tissue, and a few muscular fibres called the muscle of Guthrie or compressor urethræ, and also by Wilson's muscle.

The urethra now perforates the bulb of the corpus spongiosum, not directly at its pendulous tip, but through its superior convexity just in advance of its extremity. This portion is the longest, and commences with an enlargement called bulbous;[12] gradually it diminishes in diameter until it reaches the glans, in which it again enlarges and constitutes the *fossa navicularis.*[13] When the urethra is relaxed, longitudinal folds exist in this portion. Numerous mucous follicles are also readily seen, of which the largest is in the *fossa.* The orifices of Cowper's glands open obliquely upon the mucous membrane also, about an inch in front of the glands.

The penis is supplied by the internal pudic arteries and pudendal nerves.

VESICULÆ SEMINALES.

The seminal vesicles[9] consist of two convoluted tubes placed at the posterior and inferior portion of the bladder. They are oblong in shape, and converge downwards and forwards. Each appears to be about two inches in length, but when cleanly dissected and unravelled, it is a tube five inches in length, with numerous pouches or cæca.

The duct of the vesicle is joined by the vas deferens on either side in the prostate gland; the junction forms the *ductus ejaculatorius,* which, passing through the prostate, opens into the urethra in front of the caput gallinaginis. They contain a mixture of mucus and semen.

PROSTATE GLAND.

This[7] is a dense hard structure, about the size of a horse-chestnut, which surrounds the neck of the bladder and the commencement of the urethra. It is of a light colour, and somewhat triangular in shape, the point being in front. It is placed between the rectum which is behind, and the triangular ligament in front.

It is enveloped in a fascia, which is continuous with the posterior lamina of the triangular ligament; it may be divided into two lateral and a middle lobe. The urethra perforates the middle lobe,[8] and the projection of the uvula vesicæ and verumontanum are partially formed by it.

Its structure is composed of tubes united by condensed and hard cellular tissue. The secretion is thick and white, and is discharged by orifices into the urethra on each side of the verumontanum.

Cowper's glands.[11]—These are two in number; placed in front of the prostate; and included between the two laminæ of the triangular

ligament. They are about the size of a pea, and of a yellow colour; secreting a mucous fluid which is discharged into the urethra about an inch in front of the gland.

SCROTUM AND TESTICLES.

The scrotum is a bag-like covering for the testicles, formed externally of skin, which is of a dark colour, and thickly covered by hairs and studded with sebaceous follicles. The skin is loose and thin; on its middle is a ridge still darker in colour, which reaches from the anus to the prepuce, called the *raphe.* The transverse wrinkles of the scrotum which cold produces, are due to a structure immediately beneath and intimately connected with the skin, called the dartos.

The *dartos* is a dense, reddish, contractile covering, divided by a partition into two bags. It was once considered muscular, and the remains of the gubernaculum testis; it is principally composed of the yellow fibrous elastic tissue, with a few unstriped or involuntary muscular fibres. Its contractions are involuntary.

The position of the testicle in fœtal life, and its descent, have been noticed under the head of inguinal hernia. Beneath the dartos is a covering of superficial fascia, and the intercolumnar or external spermatic fascia.

The *cremaster* muscle sends a few fibres and loops upon the anterior and upper part of the testicle, and is sometimes called the tunica erythroides.

The next covering is that derived from the fascia transversalis, and is called the infundibuliform fascia. It is sometimes called the internal spermatic fascia, and also tunica vaginalis communis testis; by Cooper it is called the fascia propria.

The *tunica vaginalis* or *peritestis,* is the next covering. It is a serous membrane lining the cavity, and reflected over the testicle within; it was originally peritoneum, and is the seat of hydrocele.

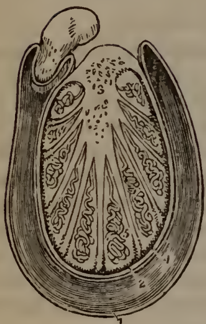
The *testicles* are the glands for the secretion of semen. They are two in number, oval in shape, and flattened laterally. They hang obliquely by the spermatic cord, being attached above the middle of the posterior edge; the right is higher than the left.

The *tunica albuginea,*[2] is the dense, white, thick, fibrous coat of the testicle, which gives it shape. In structure it resembles the dura mater or sclerotica; externally it is covered by a portion of the peritestis, which is transparent and very closely adherent; from its internal face are given off numerous partitions called *septulæ testes,* and which, uniting at the posterior edge of the testicle, form that prismatic ridge termed *corpus Highmorianum.*[3] (Fig. 102.)

The testicle is formed by *lobules,* each placed within the spaces between the septulæ. Each lobule[5] (Fig. 103) consists of a fine tube, very finely convoluted. Upon its exterior is a capillary net-work of blood-vessels;[2] interiorly it is lined by epithelium. This tube (*tubulus semi*

Fig. 103.

Fig. 102.



niferus), becoming straight forms the *vas rectum*;[4] the union of the vasa recta makes the *rete testis*,[5] which is in the corpus Highmorianum; from the upper part of this rete proceed 15 or 20 tubes through the tunica albuginea; they are called *vasa efferentia*;[6] each vas efferens is convoluted in a conical form, and termed *conus vasculosus*; the union of the coni vasculosi forms the commencement of the epididymis. (Fig. 103.)

The *epididymis*[8] is that vermiform appendage encircling the posterior edge, as a crest upon a helmet. It is soft and formed of a single convoluted tube, originating by the junction of the bases of the coni vasculosi. The upper extremity is the larger, and called *globus major*,[7] and the lower is *globus minor*.[9] From the globus minor this tube ascends in a less convoluted form, under the name of the *vas deferens*,[10] which forms one of the constituents of the cord. Connected with the epididymis is the *vasculum aberrans*,[11] a small, blind, convoluted duct.

SPERMATIC CORD.

Each spermatic cord consists of an artery and vein, and nerves, together with the duct, vas deferens. These constituents are united by cellular tissue, which may be the remains of that canal of peritoneum peculiar to fœtal life.

It is covered by the fascia transversalis prolonged from the abdomen, by the cremaster muscle, which has been previously described; and by the external spermatic fascia.

The *spermatic artery* comes from the aorta, and sometimes from the renal It is tortuous, and after passing through the rings divides into

two or three branches; the termination of the artery is larger than its origin.

The *spermatic* veins are very tortuous and numerous, and on account of their vine-like appearance are termed *vasa pampiniformia.* They are the seat of circocele.

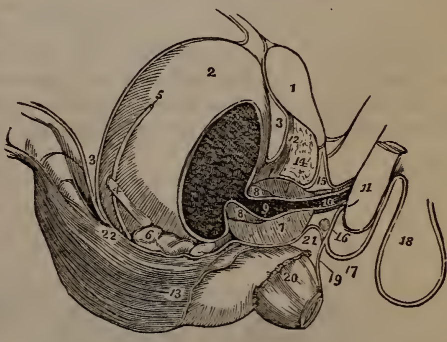
The *external spermatic nerves,* and also branches of the abdomino-crural, supply the muscular structure; filaments of the sympathetic run also to the testicle.

The *vas deferens* is a continuation of the epididymis. Passing through the cord and rings, it descends behind the bladder and joins the duct of the vesiculæ seminales. It is very hard, and readily recognised by touch; its walls are extremely thick, and its bore almost capillary. It is nearly white, and thicker than a knitting-needle.

THE PERINEUM.

The perineum is that space included between the anus, arch of the pubes, and the tuberosities of the ischia.

Fig. 104.



In a proper dissection the removal of the skin reveals the *superficial fascia,* which is continuous with the superficial fascia of other parts of the body. When this is removed, the *perineal fascia* is exhibited, which is a dense, thin, and tough fascia,[17] adhering to the rami of the pubes and ischium on each side; in front it is continued into the scrotum;[8] behind it is continuous with the base of the triangular ligament by its anterior lamina,[16] and also with the *anal fascia,*[19] a portion of the pelvic fascia. It covers the muscles of the perineum and sends processes between them. Posteriorly it winds around the transversus muscle to join the triangular ligament. Its connections laterally and behind account for the course taken by extravasated urine from rupture of the urethra.

The *triangular ligament*[15] called also deep perineal fascia, lies under the muscles of the perineum, fills up the arch of the pubes, and is shaped as its name implies. It is a fibrous membrane, separating the pelvis from the perineum. The base, which is not so dense and fibrous as its apex, joins the perineal and anal fascia.[21] It is perforated by the membranous portion of the urethra, about one inch below the symphysis.

It consists of two laminæ,[16 21] between which are situated Cowper's and the prostate gland;[7] thus the fascia of the prostate, as it is usually called, is merely the posterior lamina of the triangular ligament.

PELVIC FASCIA.

This fascia is continuous with the transversalis and iliac fascia surrounding that portion of the peritoneum which lines the pelvis. Like all fasciæ, it is easily divided into laminæ; different portions receiving different names.

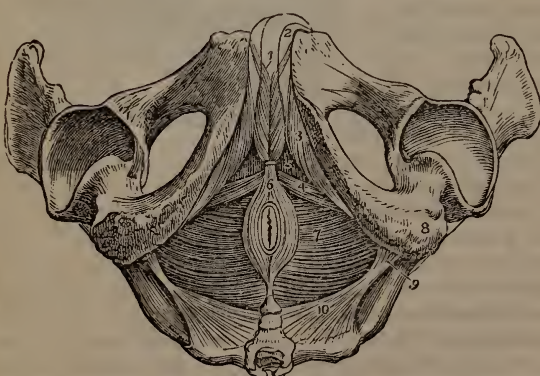
It may be said to commence at the brim of the pelvis, and by its intervention the different viscera are united with each other, and held in their proper positions. Thus, two processes of it on the sides of the bladder form the *anterior ligaments of the bladder.* A layer covering the obturator muscle is called the *obturator fascia.* The levator ani muscle is included between two layers of this fascia; that portion between the rectum and bladder is called the *recto-vesical fascia;* and that which covers the lower part of the rectum is the anal fascia.

MUSCLES OF THE PERINEUM AND ANUS.

Erector penis.[3]—*Origin,* from the tuberosity of the ischium. *Insertion,* by a broad flat tendon into corpus cavernosum.

Accelerator urinæ,[1] or *ejaculator seminis.*—It lies on the bulb of the corpus spongiosum. *Origin,* from the crus of the penis, and the

Fig. 105.



ramus of the pubes; and also by a tendinous membrane which is between the corpus spongiosum and corpus cavernosum, and is continuous with the fascia of the penis. The fibres are semi-pennate, and with those of its fellow surround the bulb. *Insertion,* by a white tendinous

line into its fellow, and into the *perineal centre*, which is formed by the junction of several muscles.

Transversus perinei.[4] — *Arises* from the tuberosity of the ischium, and is *inserted* into the perineal centre. Sometimes there is an additional portion in front, called *transversus perinei alter.*

Sphincter ani.[6]—A thick muscular ring surrounding the anus. Its superficial fibres are elliptical. It is connected with the coccyx and perineal centre.

Coccygeus.[10] — *Origin*, from the spine of the ischium. *Insertion*, into the side of the coccyx and last bone of the sacrum.

Sacro-coccygeus. — A few fibres passing from the sacrum to the coccyx in front.

Levator ani.[7]—Is a plane of muscular fibres. *Origin*, from the interior of the body of the pubes, the superior edge of the thyroid foramen, the upper edge of the obturator fascia, and the spine of the ischium. *Insertion*, by converging and descending fibres into the lateral semi-circumference of the rectum; also in the coccyx and perineal centre.

ORGANS OF RESPIRATION AND CIRCULATION.

LARYNX.

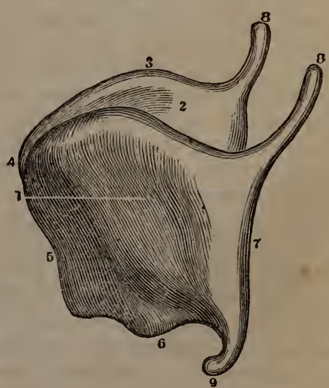
The *larynx* is a canal formed of cartilages, which move in such a manner as to regulate the voice.

It is situated in the upper and anterior part of the neck, in the median line, below the hyoid bone.

It forms the commencement of the windpipe; is cylindrical below but prismatic above; it is larger in males than in females.

The cartilages of the larynx are five in number; viz., thyroid, cricoid, two arytenoid, and epiglottis.

Fig. 106.



The *thyroid* (Fig. 106) is the largest; it occupies the upper anterior portion of the larynx. It consists of two quadrilateral plates, which are united in an acute angle in the median line in front; this angle is usually called the *pomum Adami.*[5] It is much larger in men than in women; and has a deep notch at its upper part.[4] The upper edge[3] is curved, and has the middle thyreo-hyoid ligament attached to it; the lower edge[6] is also curved, and to it is attached the middle crico-thyroid ligament. The posterior edge[7] terminates in two processes called cornua, of

which the superior[8] is the longer, and is attached to the lateral thyreo-hyoid ligament. The *inferior cornu*[9] is short and curved, and receives the lateral crico-thyroid ligament. Upon the external surface[1] is an oblique ridge, passing between two tubercles, from which arise the thyreo-hyoid and inferior constrictor muscles.

The *cricoid cartilage* is next in size (Fig. 107), and situated at the base of the larynx; its form is that of a thick ring compressed laterally; its lower edge[3] is circular, and attached to the trachea; its upper edge is oval and oblique, on account of the cartilage being three times as thick behind as it is in front; the posterior portion of the superior edge has two heads[4] of a peculiar convexity, for articulating with the arytenoid cartilages; the external surface posteriorly is flattened, giving origin to the posterior crico-arytenoid muscle.

Fig. 107.

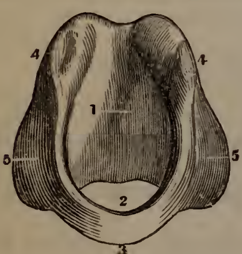
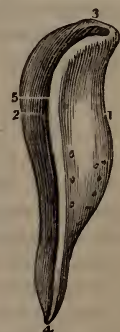


Fig. 108.

Fig. 109.



The *arytenoid cartilages* are situated at the upper and back portion of the larynx. They are two in number, and are of a pyramidal shape. The base[3] is concave, and articulates with the heads of the cricoids; the apices[2] have attached to them a small cartilage called *corniculum laryngis*, or *tubercle of Santorini.* The posterior surface[1] is triangular and concave, for the insertion of the posterior crico-arytenoid muscle; the internal surface is flat, and can be adjusted to its fellow; the anterior or external surface is uneven, to which are attached the superior and inferior thyreo-arytenoid ligaments. (Fig. 108.)

The *epiglottis cartilage* is a thin, oval, cartilaginous plate, behind the root of the tongue, and attached to the angle of the larynx; it resembles a leaf in shape; its direction is vertical; its inferior extremity[4] is narrow and pointed; its superior edge is thin, its anterior surface[1] is slightly convex, and its posterior[2] concave. It is perforated by numerous foramina. (Fig. 109.)

These cartilages are held together by numerous ligaments, of which the principal are, the *middle thyreo-hyoid*, a thin membranous expan-

sion between the inferior circumference of the hyoid bone and the superior edge of the thyroid cartilage: the *lateral thyreo-hyoid*, which is funicular, extending from the great cornu of the thyroid cartilage to the tubercle of the cornu of the hyoid bone; in this ligament is found a small oval cartilage or bone, called *cartilago triticea:* the *middle crico-thyroid*, a thick membrane, filling up the space between the superior edge of the cricoid and inferior edge of the thyroid cartilages; this is usually divided in the operation of laryngotomy: and the *lateral crico-thyroid*, reaching from the inferior cornu of the thyroid to the side of the cricoid. A *capsular ligament* surrounds the joint between the arytenoid and cricoid.

Within the larynx are two *thyreo-arytenoid ligaments* on either side. The *inferior* ligaments extend from the angle of the thyroid to the base of the arytenoid, and are usually called the vocal cords; the space between them is the *rima glottidis.* The *superior* ligaments extend from the angle of the thyroid to the middle of the arytenoid cartilages. The space between them is the *glottis.* These ligaments are not cords, as they appear to be, but merely edges of a membrane lining the larynx, and composed of yellow elastic fibrous tissue.

The mucous membrane lining the larynx is continuous with that of the mouth, and forms numerous folds between the cartilages, of which the most remarkable is a pouch between the superior and inferior thyro-arytenoid ligaments, which has been called the *ventricle* of the *larynx*, or ventricle of Galen. To the ventricle of either side is attached an additional pouch, which is called the *sinus of Morgagni.* In the fold between the arytenoid and epiglottis cartilages is a small *gland*, called the *arytenoid*, which is of the shape of the letter L.

The muscles of the larynx move the various cartilages, and modulate the voice.

Thyreo-hyoid. This was described with the muscles of the neck.

Crico-thyroid, arises from the anterior and lateral surfaces of the cricoid, and passes backwards to be inserted into the inferior cornu of the thyroid; it draws these two cartilages together obliquely.

Fig. 110.

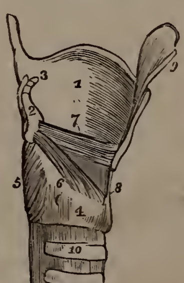
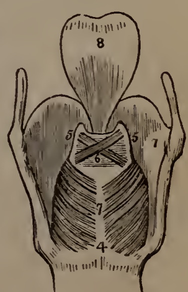


Fig. 111.



Posterior crico-arytenoid,[7] arises from the flat surface on the back of the cricoid, and is inserted into the posterior part of the base of the arytenoid; it draws the arytenoid backwards, and thus tightens the vocal ligaments. (Fig. 110.)

Lateral crico-arytenoid.[8]—Arises from the side of the cricoid, and is inserted into the side of the base of the arytenoid; it separates the arytenoid from its fellow, and widens the glottis.

Thyreo-arytenoid.[7] — Arises from the posterior face of the thyroid near the angle, and is inserted into the anterior surface of the arytenoid, which it draws forwards, and thus relaxes the vocal ligaments.

Oblique arytenoid.[5] — They consist of oblique fibres arising from the top of one cartilage, and inserted into the base of another. (Fig. 111.)

Transverse arytenoid.[6]—Arises from the side of one cartilage, and is inserted into the side of the other. These last two muscles are often considered as one, and by them the glottis is narrowed.

Thyreo-epiglottideus.—Consists of a few fibres passing between these two cartilages.

Aryteno-epiglottideus.—A few indistinct fibres passing between the cartilages from which it derives its name. These last two draw the epiglottis downwards.

TRACHEA.

The trachea (Fig. 112) is a cylindrical tube, four or five inches long, reaching from the larynx as low as the third dorsal vertebra, where it divides into the *bronchi.* It is formed of from *sixteen* to *twenty* rings of *cartilage,* united by *ligamentous* tissue, which is of an elastic character. Each ring is about two lines broad and constitutes two-thirds of a circle; the first ring is the largest, and the last ring is of such a shape as to be adapted to the first rings of the bronchi.

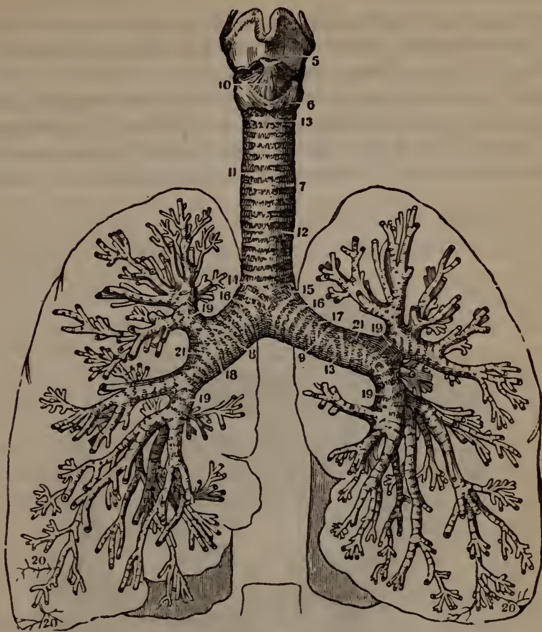
The posterior third of the trachea is completed by an involuntary *muscular* structure, whose fibres are transverse, and the contraction of which diminishes its diameter, by which expectoration is facilitated; it is lined by a *mucous* membrane continuous with that of the larynx, which is extremely vascular, and covered with numerous follicles. At the bifurcation of the trachea into the bronchi, there are a number of hard, *black* glands, which are lymphatic in their character, and called *bronchial* from their position.

The *bronchi*[8 9] are essentially of the same structure and arrangement as the trachea; the right bronchus is shorter, and of a larger diameter than the left; they soon ramify into numerous subdivisions, which finally terminate in the lobules of the lungs. In the smaller ramifications of the bronchi there is some modification of structure; the tube is no longer flattened behind, because the cartilages form complete circles; the cartilages are less numerous; each cartilaginous ring is not composed of a single piece, but of several segments of a circle; there is also a semilunar cartilage at each of the lesser bifurcations.

THYROID GLAND.

It is situated in front of the first two rings of the trachea, and upon the sides of the larynx; it consists of two lateral lobes, placed on

Fig. 112.



either side, united by a narrow isthmus in front; it is extremely vascular, of a reddish-brown colour, and of tolerably firm consistence. A process called the *pyramid* or *middle lobe* sometimes extends from the isthmus to the hyoid bone. Occasionally a small, narrow muscle attaches one lobe to the hyoid bone. The thyroid gland is granular in its structure, has no excretory tube, but very large lymphatic vessels. It consists of minute closed vesicles, surrounded by capillary vessels, and invested by areolar tissue. These vesicles are composed of an external capsule, and a yellow fluid containing corpuscles resembling cell-nuclei: albumen enters largely into the composition of the fluid. It is supplied by the superior and inferior thyroid arteries. It is sometimes much enlarged, constituting bronchocele or goitre.

THE LUNGS (FIG. 113).

The lungs are the organs of respiration properly; they are two in number, and situated in the thorax, placed side by side, being separated from the abdomen by the diaphragm. The size varies with the capacity and condition of the thorax, age, inspiration, expiration, and disease. They are conical in shape, are longer posteriorly than anteriorly, and have concave bases. The colour of the lungs is of a pink-

ish-grey, mottled with black; these black spots are more numerous in adult life than in infancy.

The right lung is shorter but larger than the left, whose transverse diameter is somewhat diminished by the position of the heart. It has three lobes,[21 22 23] the left having but two.[24 25]

The *structure* of the lungs is spongy, and its compression between the fingers produces a crackling called *crepitation.* It consists of air-vesicles[20] (Fig. 112), held together by cellular tissue, termed *parenchyma,* through which blood-vessels and air-vessels are ramified. A

Fig. 113.

certain number of air-cells communicate with each other, and with a single branch of the bronchial tube; these are separated from neighbouring cells by partitions of parenchyma, and thus are formed *lobules.* These subdivisions are evident upon the external surface of the lung. The air-vesicles are formed of ligamentous tissue lined by a mucous membrane.

The *root* of the lung consists of the bronchus,[18] pulmonary artery,[9] two pulmonary veins,[20] bronchial artery and vein, nerves and lymphatics. These enter upon its internal surface, and in some degree retain the lung in its proper position. The branches of the pulmonary artery terminate in capillaries, upon the walls of the air-vessels, from which arise the branches of the pulmonary veins.

The bronchial artery is the nutritious artery of the lung. Its nerves are derived from the sympathetic and eighth pair.

PLEURÆ.

The pleura is a serous membrane investing each lung, and then reflected upon the parietes of the chest. That portion in contact with the chest is called *pleura costalis;* that covering the lung, *pleura pulmonalis.* It also covers the diaphragm and the root of the lung, between which there exists a fold called *ligamentum pulmonis.*

MEDIASTINUM.

The space between the two pleuræ of the lungs is called the mediastinum, and it is divided, by the position of the heart, into the anterior, posterior, and superior mediastinum.

The *anterior mediastinum* is that space between the sternum and the heart; it contains some loose cellular tissue, and a portion of the remains of the thymus gland.

The *posterior mediastinum* is that region between the vertebral column and the heart, and through it passes the œsophagus, par vagum nerve, aorta, vena azygos, and the thoracic duct.

The *superior mediastinum* is above the heart, and surrounded by the first ribs and sternum; it contains the roots of the large vessels, and the remains of the thymus gland.

THYMUS GLAND.

This is a triangular body of a pinkish hue, occupying a portion of the superior and anterior mediastina. It grows until the end of the second year, after which it diminishes, and almost entirely disappears. It has a large lymphatic vessel, which has been supposed to be an excretory duct. Its structure is lobulated, and surrounded by loose cellular tissue. Each lobule contains several membranous cells or vesicles, which contain a white fluid and open into a central cavity or reservoir. The fluid contains corpuscles resembling the white blood corpuscle and the chyle corpuscle.

PERICARDIUM.

The pericardium is a membranous sac, in which the heart is contained. It consists of two layers, the external of which is fibrous, dense, and white, and the internal is serous. The serous lamina line the fibrous layer, and then is reflected over the heart and the roots of its vessels.

THE HEART (FIG. 114).

The heart is a hollow muscular organ, surrounded by a membranous sac called the pericardium. It is situated between the two pleuræ, and rests upon the cordiform tendon of the diaphragm, in the cavity of the thorax.

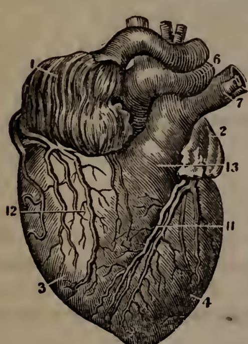
Its *shape* is conoidal, though it is somewhat flattened upon that side which rests upon the tendon of the diaphragm. Its apex inclines to the left side, touching the walls of the thorax, between the fifth and sixth ribs. It *measures* five inches and a half from its apex to its base, three inches and a half in the diameter of its base, and *weighs* about six or eight ounces. It contains *four cavities*, which perform two functions, that of receiving the blood and throwing it into the lungs, and that of receiving it again after it has been oxygenated, and distributing it throughout the body. The receptacles are *auricles*, and the *ventricles propel* the blood to the lungs and through the system.

The auricle and ventricle of the *right side* receive and propel the venous blood into the lungs. The auricle and ventricle of the *left side* receive and propel the arterial blood throughout the body.

The *circulation* of the blood is as follows: the ascending and descending vena cava empty the venous blood into the right auricle; from here it passes to the right ventricle, through an opening protected by a valve opening downwards; from the right ventricle it is propelled through the pulmonary artery, which divides into two branches, to the lungs; after it has been subjected to the influence of the respiratory process, it is brought from the lungs, by four pulmonary veins, into the left auricle. The left auricle has an opening into the left ventricle, protected by a valve opening downwards, and from the left ventricle it passes into the aorta, thence to be distributed throughout the body.

The *right auricle*[1] is an irregularly-shaped cavity, somewhat oblong and cuboidal; anteriorly, it has a convexity which is called its *sinus*; superiorly there is an elongated process resembling the ear of an animal, whence the term auricle. Its walls are thin, and composed of muscular fibres, which from their parallel arrangement resemble the teeth of a comb, and hence are called *musculi pectinati.* The superior[5] and inferior vena cavæ enter the auricle from behind, and between their orifices there is an elevation, called *tuberculum Loweri.* On the septum or partition between the auricles, is a depression called *fossa ovalis,* where formerly existed the foramen ovale of fœtal life; the ring or edge surrounding it, is called the *annulis ovalis,* from which there extends downwards to the inferior semi-circumference of the ascending cava, a crescentic doubling of the lining membrane, which is the remains of the *Eustachian* valve. The *coronary* veins open into this cavity, and their orifice is protected by the *valve of Thebesius.* The opening to

Fig. 114.



the ventricle, called the *ostium venosum,* is circular and surrounded by a dense white line.

The *right ventricle*[3] is a triangular cavity, with thick walls, and of greater capacity than any other cavity of the heart. Its muscular structure is in the form of large fleshy bundles, called *columnæ carneæ,* from which proceed thin, white cords, called *chordæ tendineæ,* which are attached to the edge of the *tricuspid valve.* The tricuspid valve is circular, and its upper edge is attached to the tendinous line of the ostium venosum; its lower edge has three spear-pointed or leaf-like processes, whence its name; since it opens downwards, the contraction of the ventricle closes the ostium venosum, and prevents the blood from returning into the auricle, and therefore it passes out by the *pulmonary artery.*[7] The orifice of the *pulmonary artery* is protected by three valves opening outwards, which are called semilunar valves, formed by three crescentic folds of the lining membrane; in their loose edges there is often a small tubercle, called *corpus Arantii:* the use of these valves is to prevent the blood returning from the artery to the ventricle, when it dilates. Behind each valve is a pouch or dilatation, called the *sinus of Valsalva,* into which the blood flows by its reflux tendency, upon the dilatation of the ventricle, and thus these valves are closed. The pulmonary artery is of the same diameter as the aorta, but its walls are thinner; after its origin it curves upwards and backwards, and divides into two branches, the right of which is larger than the left,[7] and passes under the arch of the aorta.

The *left auricle*[2] is more concealed in its natural position than the right. Into it enter four pulmonary veins, which give it a quadrangular shape. Its walls are muscular, and somewhat thicker than those of the right auricle. In its ear-like appendage the muscular fibres are arranged as *musculi pectinati;* the opening, by means of which it communicates with the left ventricle, is called *ostium venosum,* and surrounded by a white tendinous ring. The septum between the auricles is not always perfect even in adult life.

The *left ventricle.*[4]—This cavity forms the apex of the heart; it is conoidal in its shape. Its walls are thick, and its *columnæ carneæ* numerous, strong, and projecting; the *chordæ tendineæ* are well developed, and attached to the *bicuspid* or *mitral valve.* This valve consists of but two leaflets, one of which is much larger than the other; its base is attached to the ring surrounding the ostium venosum, and its edge opens downwards into the left ventricle: hence the contraction of the ventricle closes this opening, and the blood passes out by the *aorta,*[6] at whose orifice there are three *semilunar* or *sigmoid* valves, each having a corpuscle of Arantius in its edge, and *sinuses* of Valsalva or Morgagni behind them. The vessels supplying the heart with blood are the right and left coronary arteries;[11 12] the veins which accompany them empty by a common trunk into the right auricle. The nerves are derived from the cardiac plexuses of the sympathetic.

SECTION V.

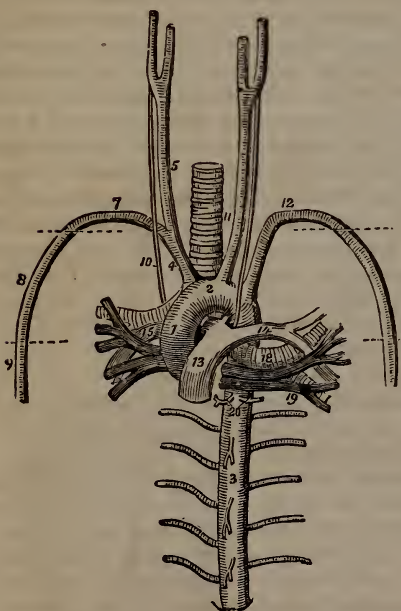
VESSELS.

STRUCTURE OF ARTERIES.

Arteries are composed of three coats; the external, middle, and internal.

The external is firm and strong, formed of condensed cellular tissue; it does not yield upon the application of a ligature.

Fig. 115.



The middle is formed of elastic, fibrous tissue, and was formerly called the muscular coat. It is thick, and its fibres are arranged circularly; in which direction they readily yield to a ligature. It contains a few involuntary muscular fibres.

The internal is a thin, serous covering, which diminishes the friction of the passage of the blood. It is smooth and transparent, and readily torn.

Arteries convey blood *from* the heart, and *veins* carry blood *to* the heart; thus, the pulmonary artery conveys blue or what is usually called venous blood, and the pulmonary veins convey red or what is termed arterial blood.

The nutritious vessels of the arteries are called *vasa vasorum*, and their nerves are derived from the sympathetic.

AORTA.

It arises[1,2] (Fig. 115) from the left ventricle opposite the articulation of the fourth costal cartilage with the sternum. At first it ascends to the right, then curves backwards and to the left, and descends on the left side of the vertebral column to the fourth lumbar vertebra. The *ascending aorta*[1] is partially covered in front and at its origin by the pul-

monary artery.[13] The upper edge of the *arch*[2] is on a level with the second dorsal vertebra, and under it passes the right pulmonary artery. It is frequently enlarged into a *sinus* in old persons. The descending aorta[3] while passing through the thorax is termed *thoracic*, and while passing through the abdomen, *abdominal*.

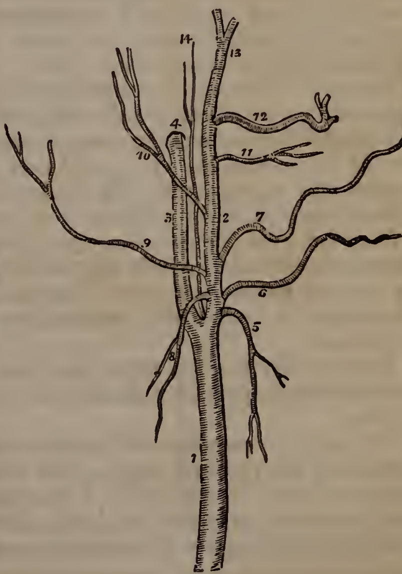
The coronary arteries are the first branches of the aorta, and are distributed to the heart, through the grooves between the auricles and ventricles. They arise just beyond the semilunar valves.

The Innominata.[4]—This artery arises from the arch of the aorta, is an inch and a half in length, ascends obliquely towards the right side in front of the trachea, and behind the transverse vein. Opposite the sterno-clavicular articulation, it divides into the right carotid and right subclavian.[7] (Fig. 115.)

The right carotid[5] arises from the innominata, and ascends the neck as far nearly as the hyoid bone, where it divides into the external and internal carotids.

The left carotid[11] arises from the arch of the aorta, ascends obliquely through the thorax until it reaches the neck, and then it is distributed as the right. Each primitive carotid is on the inner side of the internal jugular vein, with which and the par vagum nerve[10] it is included in a sheath. (Fig. 115.)

Fig. 116.



EXTERNAL CAROTID.

(Fig. 116.)

It ascends perpendicularly from the bifurcation of the carotid[1] and passing through the deep portion of the parotid gland it divides into the *internal maxillary*[12] and *temporal.*[13]

Superior thyroid,[5] arises near the root of the external carotid and is its first branch; it pursues a curved course downwards and is distributed to the thyroid gland, after giving off a *laryngeal branch.* (Fig. 116.)

Lingual,[6] ascends obliquely from its origin, which is just above the superior thyroid. It penetrates the hyoglossus muscle just above the

cornu of the hyoid bone, and then courses between the muscles of the tongue, giving off the *dorsalis linguæ*, *sublingual* and *ranine* branches. The *ranine* reaches the tip of the tongue.

Facial.[7]—This arises above the lingual, is tortuous, becomes imbedded in the submaxillary gland, and then passes over the lower jaw, in front of the insertion of the masseter muscle, and gives off several branches to the face.

Sub-mental, arises from the last, and supplies the chin.

Masseteric, also arises from the facial, and is distributed to the masseter muscle.

Inferior labial, is spent upon the integuments and muscles between the chin and the lip.

Superior and inferior coronary, surround the lips and mouth. The remainder of the facial artery is distributed by a branch upon the side of the nose and one to the inner angle of the eye, where it anastomoses with the ophthalmic.

Inferior pharyngeal,[14] arises near the bifurcation of the carotid, or from the external carotid, and is distributed to the pharynx. It often gives off the *posterior meningeal,* which enters the cranium through the *posterior foramen lacerum.*

Mastoid.[8]—This branch is irregular and uncertain in its origin, and supplies the muscles and glands of the neck.

Occipital,[9] arises from the external carotid a little below the facial, forming a loop with the hypoglossal nerve; it is distributed upon the muscles and integuments upon the back of the head, anastomosing with the temporal and its fellow.

Posterior auricular,[10] arises from the external carotid, ascends obliquely backwards, beneath the parotid gland, and passing between the external meatus and mastoid process, is distributed upon the integuments. A branch of it, called *stylo-mastoid,* enters the stylo-mastoid foramen.

Transversalis faciei,[11] arises from the carotid, and crossing the masseter muscle parallel with the duct of Steno, is distributed upon the face.

The anterior, posterior and middle temporal [12 13] are terminating branches of the temporal artery. The *anterior* is distributed upon the temple and side of the head. The *posterior* is distributed upon the integuments on the back of the head. The *middle* perforates the temporal fascia and supplies the temporal muscle.

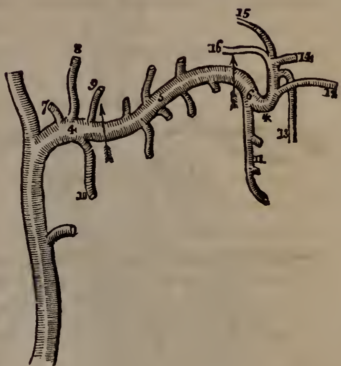
INTERNAL MAXILLARY.

This[4] commences at the bifurcation of the external carotid, and pursues a very tortuous course, supplying the back portions of the mouth and palate. At first it is horizontal, then ascending, it terminates in a horizontal course. Its branches are numerous, and are as follow: (Fig. 117.)

Tympanic,[7] is distributed to the tympanum through the Glaserian fissure.

Meningea magna,[8] passes through the foramen spinale and becomes the middle artery of the dura mater.

Fig. 117.



Meningea parva,[9] arises from the last or near to it, and is also distributed to the dura mater, having entered the cranium through the foramen ovale.

Inferior dental,[10] descends to the posterior mental foramen, and supplies the teeth of the lower jaw, then emerging at the anterior mental foramen, anastomoses with the facial.

Deep temporal.—These are two branches distributed to the temporal muscles.

Pterygoid and Buccal.—These are muscular branches supplying the muscles and the lining of the cheek.

Superior dental or *alveolar*, or *maxillary*,[11] descends, and winding round the tuberosity of the upper jaw, gives off branches to the molar teeth, antrum, and gums.

Infra-orbital,[12] enters the orbit of the eye, and passes along the infra-orbital canal; it sends branches to the teeth and integuments of the face.

Superior palatine,[13] passes through the posterior palatine foramen, and supplies the mouth and palate.

Superior pharyngeal,[15] supplies the upper part of the pharynx and the Eustachian tube; from it arises the *vidian*.[16]

Spheno-palatine,[14] enters the nose through the spheno-palatine foramen, and is distributed by branches to the mucous membrane of the nose.

ARTFRIES OF THE BRAIN.

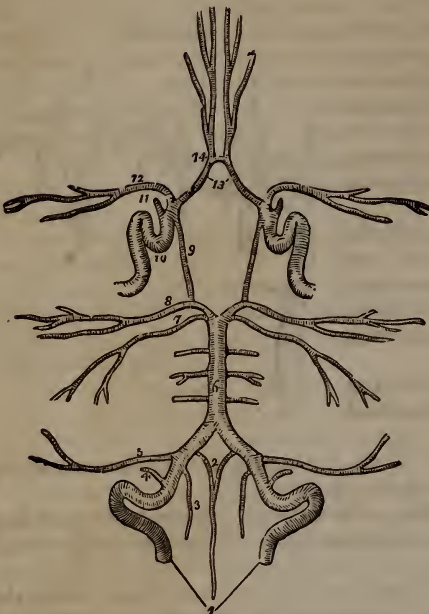
The arteries at the base of the brain are derived from the vertebrals and internal carotids. (Fig. 118.)

The *vertebral* arteries[1] enter the cavity of the cranium through the foramen magnum occipitis, and coalescing, form a thick trunk called the *basilar*.[6] Previous to their union are given off the *anterior*[2] and *posterior*[3] spinal arteries. The *inferior cerebellar*[5] arises from the vertebral also. The basilar pursues its course along the median line of the pons varolii, giving off several branches in its course. The principal being the *superior cerebellar*[7] and the *posterior cerebral* arteries.[8]

The *posterior communicating*[9] joins the carotid[10] with the posterior cerebral.

From the carotid, which enters through the carotid canal, are given

Fig. 118.

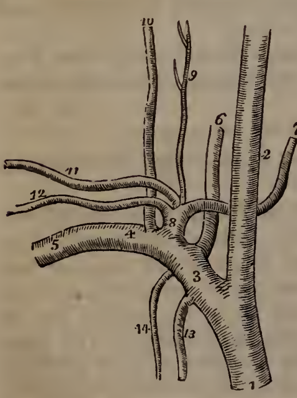


off the *ophthalmic*,[11] *middle cerebral*,[12] and *anterior cerebral arteries*.[13] The two anterior cerebral arteries are connected by a transverse branch[14] called the *anterior communicating* artery, and thus is formed the circle of Willis. These vessels are distributed to the *pia mater*, and the substance of the brain.

SUBCLAVIAN (FIG. 119).

The *subclavian*[3] of the right side arises from the innominata,[1] and the subclavian of the left side arises from the arch of the aorta. The right is shorter and more superficial than the left. The subclavian emerges from the thorax by passing over the first rib between the anterior and middle scaleni muscles. Its branches are numerous, and vary in their mode of origin. Some arise by a common origin,[8] called the *thyroid axis*.

Fig. 119.



Vertebral,[6] is the first and largest branch of the subclavian. It passes through the foramina of the transverse processes of the six superior cervical vertebræ, and enters the cavity of the cranium through the foramen magnum occipitis.

Inferior thyroid,[7] arises from the thyroid axis or from the subclavian, and curves forwards and upwards behind the great vessels of the neck to supply the thyroid gland, giving off the *ascending* or *superficial cervical*.[9]

Superior intercostal,[14] arises from the subclavian, and descending, supplies the two upper intercostal spaces. It frequently gives off the *profunda cervicis*.[10]

Internal mammary,[13] is larger than the last, and entering the cavity

of the thorax, descends within a few lines of the sternum, giving off branches to the diaphragm, thorax, and abdomen.

Posterior or *transverse cervical*,[11] arises from the subclavian in an irregular manner, and winds round the root of the neck, in front of the brachial plexus and scalenus anticus muscle, until it reaches the base of the scapula, along which it descends, and supplies the muscles upon the back. The subclavian artery, passing under the subclavius muscle, is afterwards called *axillary*.

Fig. 120.

Profunda cervicis,[10] arises from the subclavian or the superior intercostal. It ascends the back of the neck between the complexus and semi-spinalis colli muscles.

Supra-scapular, or *transversalis humeri*.[12]—This usually arises from the thyroid axis, but sometimes from the subclavian, or from the axillary. It passes over the scapula, and supplies the muscles upon its dorsum, sending a small branch through the coracoid notch.

AXILLARY.

This artery may be considered as extending from the lower edge of the subclavius muscle to the lower margin of the tendon of the latissimus dorsi.

External mammaries.[12]—These are usually four in number, arising singly or together, from the axillary. They are the *acromial thoracic*,[11] distributed upon the shoulder, and sending a branch between the pectoralis major and deltoid muscles; the *superior* and *inferior thoracic*,[12] which are distributed upon the *pectoralis* and the *serratus magnus muscles*; and the *axillary thoracic*, which is distributed to the fat and glands of the axilla.

Scapular.[14]—This is the largest branch of the axillary; it passes along the external edge of the scapula, and gives off a large branch, called *dorsalis scapulæ*, which anastomoses with the supra-scapular, on the dorsum of the scapula.

Anterior and *Posterior Circumflex*, arise from the axillary, opposite the neck of the humerus. The anterior is small, and supplies the front of the joint; the posterior is large, and passes backwards, sup-

plying the joint and deltoid muscle. Sometimes it arises from the *profunda major.*

BRACHIAL.

The *brachial* artery extends from the axilla to the elbow joint, descending upon the inner edge of the coraco-brachialis and biceps flexor muscles, in company with the median nerve. (Fig. 120.)

Profunda major,[15] arises from the brachial at its upper part, and passing between two heads of the triceps muscle, with the spiral nerve, supplies the external portion of the arm, and at the external condyle inosculates with the *radial recurrent.*

Profunda minor,[16] is small, arises below the last, is distributed superficially about the internal condyle, and anastomoses with the *ulnar recurrent.*[18]

Nutritious artery, arises opposite the nutritious foramen of the humerus, which it enters to supply the bone.

Anastomotic,[17] arises from the brachial just above the elbow, and winding around the internal condyle, anastomoses with the *ulnar recurrent.* (Fig. 121.)

The brachial, passing under that portion of the brachial fascia which is connected with the tendon of the biceps, divides into the *radial* and *ulnar,* although this division may take place at any point between the arm-pit and elbow.

RADIAL.

The *radial*[12] is more superficial than the ulnar. It descends the outer side of the arm,[12] between the tendons of the supinator radii longus and flexor carpii radialis.

Radial recurrent,[13] arises from the radial and inosculates with the profunda major. In its descent, the radial gives off numerous muscular branches, until it reaches the wrist, it then passes backwards under the extensor tendons of the thumb.

Superficialis volæ,[14] is given off from the radial, and distributed upon the palmar surface of the thumb, joining the superficial arch.

Dorsalis carpi, arising from the radial, is distributed upon the back of the wrist beneath the extensor tendons.

Magna pollicis, one of the terminating branches of the radial, supplying the thumb.

Radialis indicis,[17] arises in connexion with the last, and is distributed upon the radial side of the forefinger.

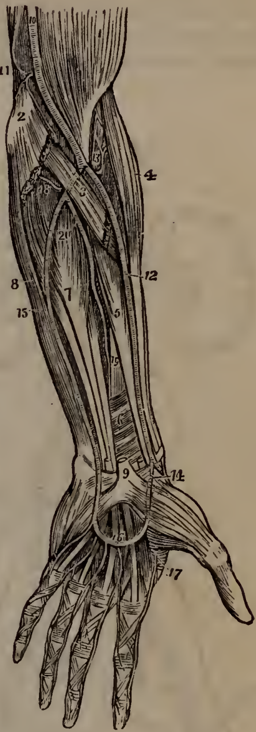
Palmaris profunda or *deep arch,* another terminating branch of the radial, which passes between the flexor tendons and bones of the metacarpus, to join the cubitalis manus of the ulnar.

ULNAR.

It passes [15] under the bellies of several superficial muscles arising from the internal condyle, and descends the inner side of the arm,

between the tendons of the flexor carpi ulnaris and flexor sublimis muscles; then passes over the annular ligament of the wrist, to form the superficial arch. (Fig. 121.)

Fig. 121.



Ulnar recurrent,[18] arises from the ulnar near its commencement, and then winding under the internal condyle, anastomoses with the anastomotic.

Interosseous,[19] arises from the ulnar opposite the tubercle of the radius, and divides into an anterior and posterior branch; the anterior interosseous descending to the wrist in front of the interosseous ligament; the posterior perforates the ligament, and is distributed to the extensor muscles of the arm.

Dorsalis manus, arises from the ulnar, and is distributed upon the back of the hand.

Superficial arch,[16] is a continuation of the ulnar artery, immediately beneath the palmar fascia.

Cubitalis manus profunda, a branch of the ulnar, arising near the superficial arch; it joins the deep arch.

Digital arteries. These are three in number, and arise from the superficial arch. At the metacarpo-pharyngeal articulation, they divide into the *digito-radial* and *digito-ulnar*, for each side of the finger. The ulnar side of the little finger is supplied by a distinct branch from the superficial arch.

THORACIC AORTA.

The Thoracic Aorta descends upon the left side of the vertebral column through the posterior mediastinum.

Bronchial,[20] vary in size and origin. Sometimes arising by a common trunk of the arch of the Aorta. They enter the root of each lung, and supply its parenchymatous structure, glands, &c. (Fig. 115.)

Œsophageal,[3] are from four to six in number, arising from the anterior convexity of the aorta, to be distributed to the œsophagus.

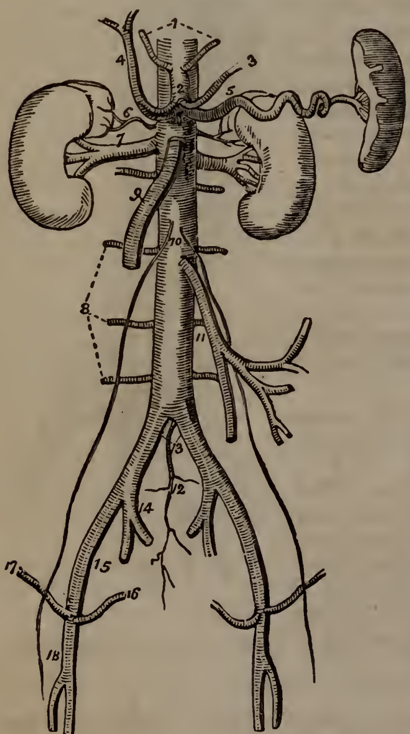
Intercostal.[21]—These are ten in number on each side, arising from the posterior convexity of the aorta.

They supply the ten inferior intercostal spaces, the right being somewhat longer than the left. They are received in the intercostal groove upon the under edge of each rib, for two-thirds of its length.

ABDOMINAL AORTA.

The Abdominal Aorta commences at the hiatus aorticus of the diaphragm and terminates at the junction of the fourth and fifth lumbar vertebræ, in the iliacs and middle sacral.

Fig. 122.



Phrenic.[1] — These are two in number, one for each side of the diaphragm, to which they are distributed; sometimes they arise by a common trunk from the cœliac.

Cœliac axis.[4] — A short, thick trunk, about half an inch in length, given off opposite the junction of the last dorsal and first lumbar vertebræ; it divides into the gastric, hepatic, and splenic.

Gastric,[3] is the smallest branch of the cœliac, and supplies the lesser curvature of the stomach.

Hepatic,[4] enters the transverse fissure of the liver, and divides into two or three branches, before entering the substance of the liver. It gives off the *cystic*, which supplies the gall-bladder and the *right gastro-epiploic*, which supplies the right side of the greater curvature of the stomach.

Splenic.[5] — This is the largest branch of the cœliac. It is very tortuous, and passes transversely to the spleen over the upper edge of the pancreas; from it are given off the *vasa brevia* and *left gastro-epiploic arteries*, supplying the left extremity and left side of the greater curvature of the stomach.

Superior mesenteric,[9] arises immediately below the cœliac and is nearly as large. It passes beneath the pancreas and over the duodenum, and descending towards the right side it forms a curvature, the convexity of which is to the left. (Fig. 123.) From it are given sixteen or twenty large branches, which form an arch;[16] from this arch are given off secondary branches to form a second arch, and from this

a third is formed. From this last arch the branches are derived which supply the small intestines. From the superior mesenteric are also given off three branches to the right side of the large intestine: *ileo-colica*[15] supplying the cæcum and a portion of the ileum; *colica dextra* supplying the ascending colon, and *colica media*[11] supplying the arch of the colon.

Fig. 123.

Capsular,[5] arise from the aorta or renal, and supply the supra-renal capsules. (Fig. 122.)

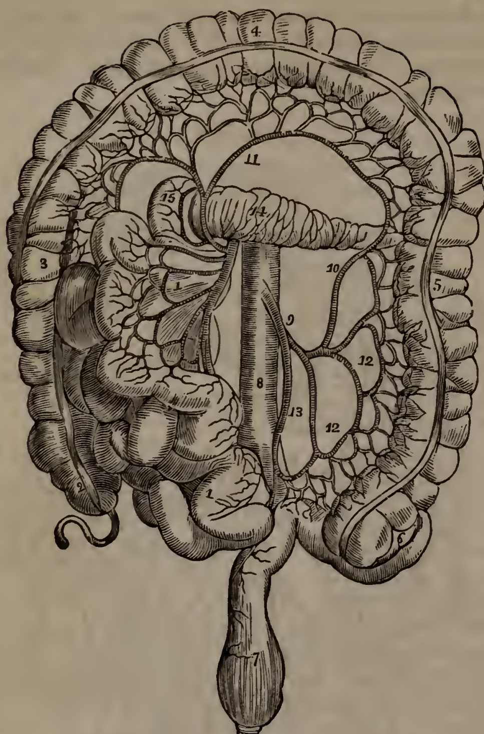
Renal or *Emulgent*.[17]—These are of large diameter, though not very long. They pass transversely to the kidney, and divide into several branches before entering it. The right is longer and more oblique in its course than the left, and is partly concealed by the ascending vena cava. (Fig. 122.)

Spermatic.[10]—These are about the size of a large knitting-needle, arising from the aorta and sometimes from the renal. They are tortuous in their course and pass through the abdominal rings; after which they divide into several branches before reaching the testicles.

In the female, they are distributed to the ovaries.

Inferior mesenteric,[11] arises from the aorta an inch above its bifurcation. (Fig 124.) It is about the size of a goose-quill, and gives

Fig. 124.



off the *superior left colic,*[11] *middle left colic,*[12] *and inferior left colic* arteries, which supply the descending colon, and also the *superior hemorrhoidal,*[13] which is distributed to the upper part of the rectum.

Lumbar.[8] (Fig. 122.) Arise on each side of the aorta, and are four or five in number; they correspond with the intercostals of the chest, and supply the muscles of the loins and abdomen.

Middle sacral.[12]—Is the termination of the aorta arising at its bifurcation into the iliacs. It descends along the median line of the sacrum.

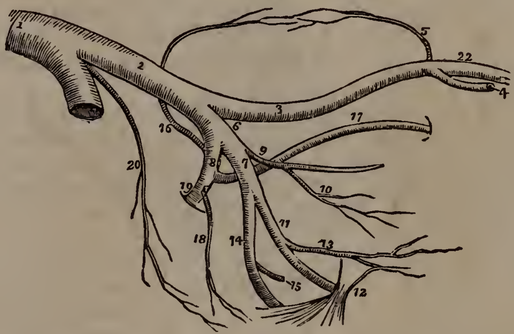
COMMON ILIAC.

The aorta[1] divides into the *iliacs* at the lower part of the fourth lumbar vertebra. The iliac[2] descends obliquely outwards to the sacro-iliac articulation, being crossed by the ureter, and divides into the *external*[3] and *internal iliac.*[6] (Fig. 125.)

INTERNAL ILIAC.

This is a short trunk,[6] descending in front of the sacro-iliac junction into the cavity of the pelvis, and giving off numerous branches with great irregularity and variety from its two principal trunks, the *gluteal*[8] and *ischiatic*.[7] (Fig. 125.)

Fig. 125.



Ilio-lumbar.[16]—Arises from the internal iliac or one of its principal trunks, ascends outwardly toward the crest of the ilium, and is spent upon the loins, anastomosing with the circumflex ilii.

Obturator.[17]—May arise at various parts of the internal iliac, and passing forwards below the brim of the pelvis, escapes from it at the upper part of the thyroid foramen; it is distributed by two branches upon the obturator and adductor muscles. Sometimes it arises from the epigastric.

Lateral sacral.[18]—This artery sends four branches through the anterior sacral foramina, anastomosing with the middle sacral.[20]

Gluteal.[19]—Is a continuation of the posterior trunk. It passes out of the pelvis at the upper part of the sacro-sciatic notch above the pyriformis muscle, and is distributed by two or three branches, to the glutei muscles.

Vesical.[10]—Arises from the remains of the *umbilical*,[9] or from the internal iliac, and is spent upon the bladder. There is sometimes an inferior vesical.[15]

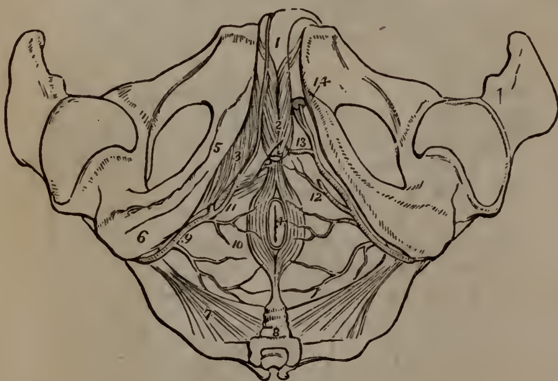
Middle hemorrhoidal.[13]—Is of variable size and origin. It is distributed to the rectum, vesiculæ seminales, and prostate gland.

Ischiatic.[14]—Is the anterior of the two principal trunks of the internal iliac. It passes out of the pelvis through the sciatic notch, between the pyriformis muscle and great sacro-sciatic ligament. It supplies the muscles on the floor of the pelvis and back of the thigh.

Internal pudic.[11]—Arises from the last, previous to its emergence

from the pelvis. It also escapes from the pelvis, and returns between the sciatic ligaments; ascending upon the ramus of the ischium and pubes, it supplies the penis and perineum. (Fig. 126.)

Fig. 126.



Lower hemorrhoidal.[10]—Arises from the internal pudic,[9] and is distributed upon the anus and rectum. There are sometimes two arteries.

Transverse perineal.[11 12]—Arises near the crus of the penis, and runs across the transverse perineal muscles. It is cut in the lateral operation for stone.

Urethro-bulbar.[13]—Is given off from the pudic near its perforation of the triangular ligament, and enters the corpus spongiosum, which it supplies.

Dorsalis Penis.—Ascends until it gets under the arch of the pubes, and then runs along the back of the penis.

Cavernous.[14]—Another terminal branch which enters the corpus cavernosum.

EXTERNAL ILIAC.

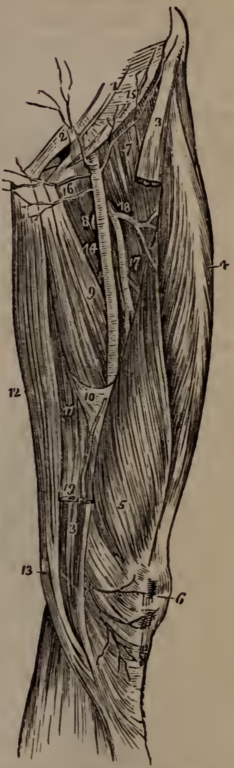
This artery[3] extends (Fig. 125) from the sacro-iliac junction along the inner border of the psoas magnus muscle to the crural arch; when it passes under Poupart's ligament it becomes the *femoral.*[22]

Epigastric.[4]—Arises from the external iliac just behind Poupart's ligament, and ascends obliquely upwards and inwards, in the transversalis fascia, and between the two abdominal rings, whereby it is endangered in the operation for hernia. A branch of it supplies the cremaster muscle.

Circumflex ilii.[5]—Arises from the external iliac opposite the epigastric, and ascends obliquely until it reaches the crest of the ilium, where it divides and supplies the muscles of the loins and abdomen.

The last two arteries anastomose freely with the internal mammary and lumbar arteries.

Fig. 127.



FEMORAL.

This artery commences at Poupart's ligament, being a continuation of the external iliac. It passes spirally down the inner side of the thigh, and perforating the tendon of the adductor magnus muscle, becomes the *poplital.* Its upper third is superficial, and upon the outer side of the femoral vein. Its lower two-thirds are covered by the sartorius muscle.

Superficial artery of the abdomen,[2] arises from the femoral, just below Poupart's ligament, and ascends obliquely upon the integuments on the lower portion of the abdomen. It may be cut in the operation for inguinal hernia.

External pudics.[15 16]—These are several branches, arising from the upper part of the femoral, and distributed to the integuments and glands of the groin.

Profunda,[17] is almost as large as the femoral, from which it arises at about two inches below Poupart's ligament. It passes downwards and backwards between the adductor brevis and vastus internus muscles.

External circumflex[18] is a branch of the profunda, and passes outwards between the rectus and cruræus, to supply the upper part of the muscles of the thigh.

Internal circumflex,[8] is larger than the external, and supplies the muscles upon the inner side of the thigh, and gives off a *perforating* artery. The *perforating* arteries are branches of the internal circumflex and profunda, which perforate the adductor magnus, and supply the muscles upon the back of the thigh.

Anastomotic,[19 6] arises from the femoral above its perforation of the adductor magnus tendon, and anastomoses with the articular arteries of the knee.

POPLITEAL.

This artery is a continuation of the femoral, and extends from the perforation in the adductor tendon, to its division into the anterior and posterior tibial below the knee. (Fig. 129.)

Superior articular.[9]—These are two in number, one internal and one external, given off above the condyles, anastomosing with each other and the anastomotic artery.

Inferior articular.—These are also external and internal, and supply the knee-joint below the head of the tibia.

Middle articular.—Is small, and perforates the ligament of Winslow, to supply the interior of the joint.

Gemellar.—These supply the heads of the gastrocnemius muscle.

POSTERIOR TIBIAL.

This artery[11 12] descends the back of the leg, under the muscles which form its calf, and nearer to the tibia than the fibula. (Fig. 129.)

Fig. 128.

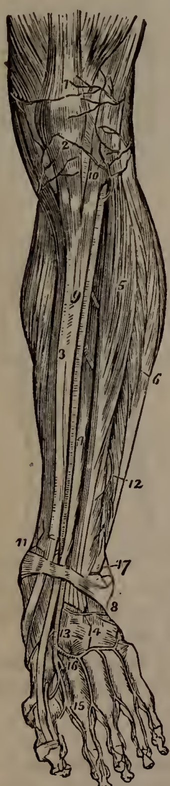
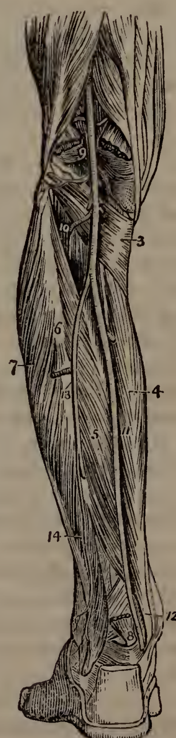


Fig. 129.



Peroneal or *fibular*,[13 14] arises from the posterior tibial, and divides into several branches, which are distributed upon the muscles arising from the fibula.

As the posterior tibial approaches the ankle, it passes between the internal malleolus and the tendo Achillis into the sinuosity of the os calcis.

ANTERIOR TIBIAL.

This artery[10] (Fig. 129) perforates the interosseous membrane, at its upper part, and descends in front of it to the ankle. Its upper third[9] is situated between the tibialis anticus and extensor longus digitorum muscles; below, it runs between the tibialis anticus and extensor proprius pollicis. In its course it gives off numerous muscular branches, and when it reaches the ankle becomes more superficial, being covered by the tendons upon the instep.

Recurrent tibial[10] (Fig. 128), ascends beneath the tibialis anticus, and anastomoses with the articular arteries of the knee-joint.

Internal malleolar.[11]—Arises from the anterior tibial above the ankle-joint, and is distributed upon its inner side.

External malleolar.[17]—Arises below the last, and is distributed upon the outside of the ankle.

Tarsal.[8]—Arises from the anterior tibial, and arches transversely across the tarsus, beneath the extensor brevis digitorum muscle.

Metatarsal.[14]—Arches across the bases of the metatarsal bones, and gives off three interosseal branches, which supply the toes.

Dorsalis hallucis.[15]—Is the terminating branch of the anterior tibial, and supplies the outer side of the great toe and the inside of the second toe.

Pedal.[16]—This branch forms the communication between the anterior tibial and external plantar arteries. It descends to the sole of the foot, through the first interosseous muscle.

Fig. 130.

PLANTAR.

These arteries (Fig. 130) are two in number, and are branches of the posterior tibial,[5] which reaches the sole of the foot through the sinuosity of the os calcis.

External plantar.[7]—This is the larger of the two, and passing obliquely outwards upon the sole of the foot, it forms a deep arch[8] above the muscles of the foot. From it are given off digital arteries for the supply of the interosseous spaces, which bifurcate into the external and internal branches, and supply the toes. The external plantar terminates in the pedal artery.

Internal plantar.[6]—This is a small artery, which passes along the

inner border of the foot, and terminates in the digital artery of the great toe.

VEINS.

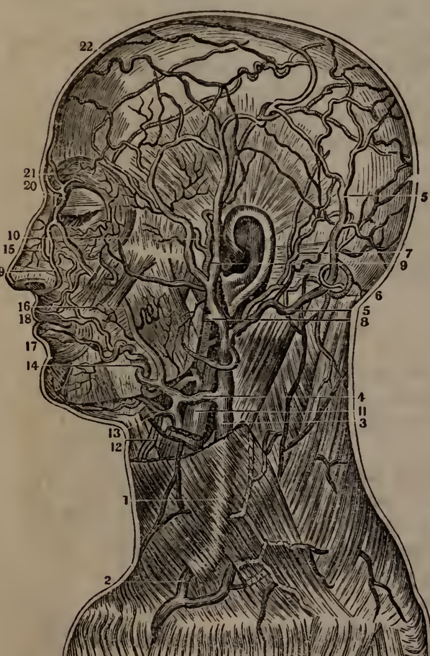
The veins return the blood to the heart. They are much more numerous than the arteries, and differ from them in having valves opening towards the heart.

These valves are formed of two or three crescentic folds of the lining membrane, and give the veins a knotty appearance when injected. They are more numerous in the superficial vessels.

The veins have three coats, but they are much thinner than those of the arteries; this deficiency, particularly in the middle elastic coat, gives them a flaccid appearance when empty, whereby they can be readily distinguished from arteries, which retain their cylindrical character.

The *superficial* veins are more tortuous and irregular than the deep. The *deep* accompany all the arteries, with the exception of those of the largest class. There are two veins for each artery, and they are called *venæ comites*, or *satellites*.

Fig. 131.



Sinuses are channels conveying venous blood, and lined by the internal coat of the veins.

The distribution and anastomoses of the veins are much more irregular than those of the arteries.

VEINS OF THE HEAD AND NECK.

The venous blood from the face is for the most part collected by veins accompanying the arteries, and which have the same name.

The principal trunks, viz., the *temporal*,[9] *internal maxillary*,[8] *and occipital*,[5] join to form a superficial vein of the neck, called *external jugular.*

External jugular.[3]—Receives the blood from the temporal, occi-

pital,[6] and internal maxillary. It commences at the lower edge of the parotid gland, and descends the neck superficially, being merely covered by the skin, platysma myoides muscle, and superficial fascia. Its course is towards the middle of the clavicle. It crosses obliquely the sterno-cleido-mastoid muscle, and empties into the subclavian vein, outside of the origin of this muscle. It is frequently selected for bleeding in children.

Internal jugular.[11]—This vein is the largest of the neck. It receives the blood from the lateral sinus of the dura mater, and also from some superficial veins.

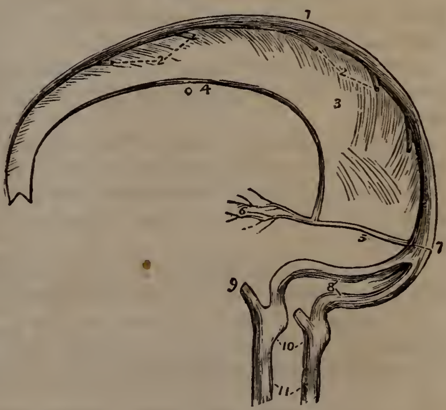
The facial vein [16] empties into the internal jugular, and also forms a communication [4] between it and the external jugular. The internal jugular descends the neck in a sheath with the carotid artery, being on the outer side. The par vagum nerve is in the same sheath and between the vessels. This vein empties into the subclavian on the inner side of the origin of the sterno-cleido-mastoid muscle. This junction forms the *vena innominata.*

SINUSES OF THE DURA MATER.

These are channels between the laminæ of the dura mater, which remove the blood from the brain. (Fig. 133.)

Superior longitudinal sinus.[1]—This is a triangular channel, commencing at the foramen cæcum by a small vein from the nose, and gradually increasing in size by the junction in an oblique manner, of the veins of the pia mater.[2] It forms an arch in the median line of the vault of the cranium, which terminates at the internal occipital cross in an enlargement called *Torcular Herophili.*[7]

Fig. 132.



Inferior longitudinal sinus.[4]—This is situated in the inferior margin of the falx cerebri; it empties into the straight sinus at the inferior edge of the tentorium.

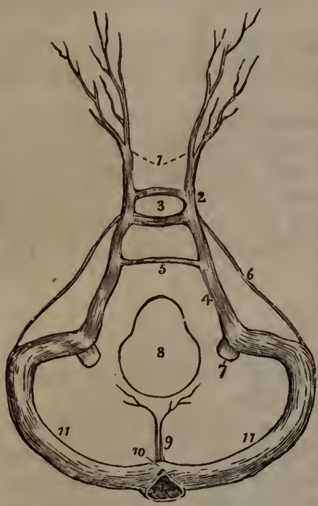
Straight or *Fourth sinus.*[5]—It reaches from the junction of the inferior longitudinal sinus to the torcular Herophili, in the median line of the tentorium, where it is joined by the falx cerebri.

Venæ Galeni.[6]—These veins are in the velum interpositum; they

frequently unite into a trunk called *vena azygos,* before entering the straight sinus.

Lateral sinuses.[11]—These commence at the torcular Herophili, are oval-shaped channels, and pursue a curved course over the occipital, parietal, and temporal bones, until they reach the posterior foramen lacerum or jugular foramen, where they emerge, and form the commencement of the internal jugular vein.[7] In their course they receive blood from several other sinuses. (Fig. 133.)

Fig. 133.



Cavernous sinuses,[2] are venous cells on either side of the *sella turcica,* containing a spongy structure; into them empty the ophthalmic veins,[1] and through them pass the internal carotid artery and the sixth nerve.

Circular sinus.[3]—It surrounds the pituitary gland in the *sella turcica,* and communicates upon each side with the cavernous sinus.

Superior petrosal sinus.[6]—This is a small sinus, running along the edge of the petrous portion of the temporal bone, and reaches from the cavernous to the lateral sinus.

Inferior petrosal sinus.[4]—Extends from the cavernous sinus on each side, along the inferior margin of the petrous portion of the temporal bone, and opens into the lateral sinus near its exit from the cranium.

Anterior occipital sinus.[5]—It passes transversely across the basilar process of the occipital bone, connecting the two inferior petrosal sinuses.

Posterior occipital sinus.[9]—This is in the inferior edge of the falx cerebelli, descending from the torcular Herophili; when it reaches the foramen magnum, it bifurcates and empties into the lateral sinus upon each side. This communication is not represented in the diagram.

The venous blood from the channels in the diploic structure empties into the sinuses at the base of the cranium.

Emissaries of Santorini, are small veins passing through minute foramina of the bones of the cranium and forming a communication between the vessels of the scalp and the sinuses of the brain.

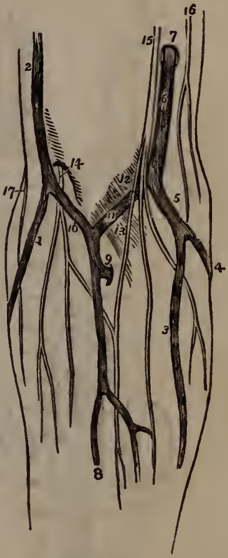
VEINS OF THE UPPER EXTREMITY.

The superficial veins of the upper extremity are readily seen be-

neath the skin; the *deep veins* have the usual arrangement of the *venæ comites.* The *superficial veins* are the following:

Cephalic.[2] — This originates upon the thumb by a branch called *cephalica pollicis,* and also upon the back of the hand, ascending upon the radial side[1] of the forearm, it is joined at the elbow by the *median* cephalic. It pursues its course along the outer side of the biceps, and entering a fissure between the *pectoralis major* and *deltoid* muscle, it empties into the subclavian vein under the clavicle. It sometimes communicates with the external jugular.

Fig. 134.



Basilic,[7] commences with the *vena salvatella* of the little finger, and receiving large branches[3 4] upon the ulnar side of the forearm, it is joined at the elbow by the median basilic. It then ascends the arm along the inner edge of the biceps muscle, and about its middle it joins the venæ comites to form the *axillary* vein.

Median.[8] — This collects the blood from the anterior face of the fore-arm, and near the elbow communicates[9] with the deep veins. It afterwards divides into the *median basilic*[11] and *median cephalic.*[10] The latter is the smaller of the two, and under it pass branches of the external cutaneous nerve.[14] A branch of the internal cutaneous nerve[12 13] passes over the median basilic, and may be cut in bleeding.

Axillary. — It is formed by the junction of the basilic with the venæ comites of the brachial artery. It lies in front of the artery, and at the subclavius muscle terminates in the subclavian vein.

Subclavian. — This is a continuation of the axillary. It passes under the clavicle and over the first rib to join the internal jugular and form the vena innominata. It lies in front of the artery, and is separated from it while passing over the first rib by the scalenus anti-·us muscle.

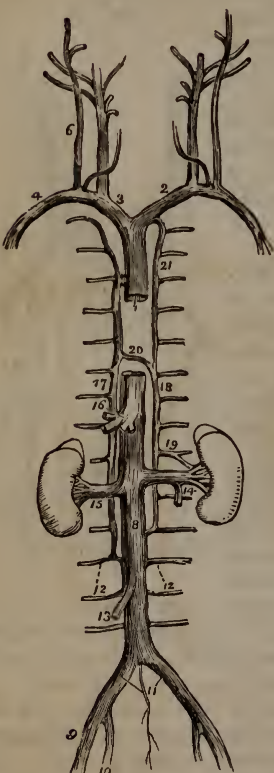
SUPERIOR OR DESCENDING VENA CAVA.

The veins which form the descending cava[1] are the right and left venæ innominatæ.

Right Innominata,[3] is about an inch and a quarter in length, and is formed by the junction of the internal jugular[5] and subclavian[4] veins. At this junction it receives the right thoracic duct. It descends superficially and obliquely in front of the arteria innominata to join its fellow.

Left Innominata.[2]—This is much longer than the right, and is formed in the same manner. It receives at its commencement the left thoracic duct. It passes horizontally across the chest in front of the large vessels arising from the arch of the aorta, and behind the first bone of the sternum. It is frequently called the *transverse vein.* With its fellow, it forms the *descending* vena cava.

Fig. 135.



The descending vena cava is about three inches in length, and descends perpendicularly to enter the upper part of the right auricle.

INFERIOR OR ASCENDING VENA CAVA.

This is formed by the junction of the iliac veins[11] between the fourth and fifth lumbar vertebræ. It ascends[8] upon the vertebral column to the right of the aorta, and in its course receives the lumbar, right spermatic, renal, and hepatic veins; it passes through the fissure of the liver between the right lobe and the lobulus Spigelii, and then enters the foramen quadratum of the diaphragm, to terminate at the right auricle of the heart.

Spermatic veins.—These originate in the vasa pampiniformia of the cord and testicle. The *right*[13] empties into the ascending cava, and the *left*[14] into the left renal.

Renal or Emulgent.[15]—These are large, and return the blood from the kidney to the ascending cava. The right[15] is much shorter than the left. The left passes in front of the aorta.

Hepatic.[16]—These convey the venous blood from the liver by three large branches, which open at its posterior notch, into the ascending cava, as it passes through the fissure in the liver.

VENA AZYGOS.

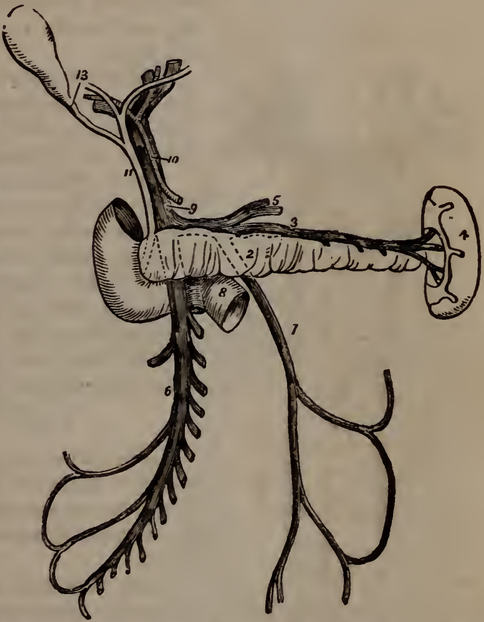
This vein[17] commences in the lumbar regions, and being joined by the intercostal veins of the right side, it winds around the root of the right lung, and empties into the descending cava. It also receives the right bronchial and the right superior intercostal veins.

Vena hemiazygos.[18]—This is formed by the lower intercostal and superior lumbar veins, and passes in front[20] of the vertebral column to join the vena azygos.

Left superior intercostal.[21]—This receives the blood from the six superior intercostals, and the left bronchial vein; it forms a communication between the left subclavian and azygos veins.

The above veins form a communication between the venous blood of the upper and lower extremities, independent of its mingling in the heart. (Fig. 135.)

Fig. 136.



PORTAL VEIN.

This vein[9] (Fig. 136) collects the blood from the chylopoietic viscera, and entering the transverse fissure of the liver, divides into the right and left sinuses. In its course it receives the inferior[1] and superior[6] mesenteric veins, splenic,[3] and gastric;[5] and then is included with the hepatic artery,[10] and the ductus communis choledochus[11] in the capsule of Glisson. The veins forming the portal vein have no valves.

Vesical plexus.—This plexus surrounds the neck of the bladder, seminal vesicles, prostate gland; its blood passes into the internal iliac vein.

Uterine plexus.—Surrounds the uterus and vagina, and empties as the vesical does.

Hæmorrhoidal veins.—Surround the rectum, and empty into th inferior mesenteric and internal iliac veins.

VEINS OF THE LOWER EXTREMITY.

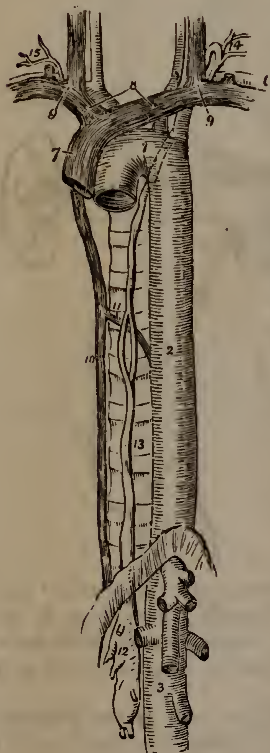
The superficial veins of the lower extremity are two in number.

Internal saphena.—Commencing upon the inside of the foot and

ankle it ascends upon the inside of the leg, and passing behind the internal condyle, it traverses the superficial fascia of the thigh and enters the femoral vein at the saphenous opening of the fascia lata.

External saphena.—Commencing upon the outer and posterior parts of the foot, it ascends upon the back of the leg and enters the popliteal vein above the knee.

Fig. 137.



Popliteal, is formed by the junction of the deep veins accompanying the anterior and posterior tibial arteries. It is superficial to the popliteal artery.

Femoral vein.—The femoral vein commences at the opening in the adductor magnus tendon, and ascends the thigh in company with the femoral artery. It passes under Poupart's ligament, to become the external iliac vein. It lies upon the inside of the femoral artery, as it passes over the pubes, and forms the outer boundary of the crural ring.

LYMPHATICS.

Lymphatics are small, pellucid vessels found in almost all portions of the body. They are exceedingly numerous, and are found most constantly in company with veins.

They enter the lymphatic glands which are most numerous in the neck, groin, axilla, loins, and mesentery, and then emerge from them.

The lymphatics of the intestine, commence in the villi of the intestine; they are often called *lacteals*, and contain the chyle.

They have three coats, like arteries, and present a knotted appearance when distended, owing to the existence of sinuses and valves.

Left thoracic duct.[13]—This is the principal lymphatic vessel of the body; it receives the contents of the lymphatics or absorbents of the lower extremity, by an enlargement called *receptaculum chyli*[12] (Pecquet); and entering the thorax through the hiatus aorticus, it traverses the thorax through the posterior mediastinum in front of the vertebral column, and between the vena azygos[10] and aorta.[2] After reaching the fourth dorsal vertebra it ascends obliquely to the left side, and enters[14] the junction[9] of the left subclavian and the internal jugular veins.

Right thoracic duct.[15]—It is a short trunk, formed by the union of the lymphatics of the right side of the head and neck, and right upper extremity. It terminates at the junction of the right subclavian in the right internal jugular vein.

SECTION VI.

NERVOUS SYSTEM.

THE principal *divisions* of the nervous system are the Brain, Spinal Marrow, and Nerves.

The *tissue* of this system is included in membranes or sheaths, and consists of two differently coloured pulpy materials; one of which is the *white* or *medullary*, and the other the *gray*, *cortical*, or *cineritious*.

The *white* or *medullary structure* is *fibrous;* in the centre of each fibre or tubule is a stripe called the *cylinder axis of Purkinje*.

The *gray* is more vascular, and is *vesicular* in its structure. These vesicles contain a nucleus with a nucleolus. They are soft, and of a yellow or brownish colour.

All ganglia and nervous centres consist of a mixture of white fibres and gray globules. (See "Physiology.")

The sheath of the nerves is called the *neurilemma*, and the internal material *neurine*.

An *anastomosis* is the interchange of fasciculi between two trunks; each fasciculus remaining unaltered by, although in contact with, another.

A *plexus* is a combination of anastomoses into a network.

Fig. 138.

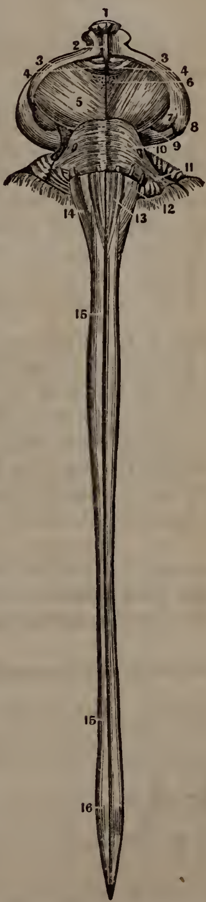


Fig. 139.

Pacinian corpuscles are small elliptical bodies, found attached to the ulnar and digital nerves. They are of a dull white colour, or opalescent, and about two-thirds of a line in length.

MEMBRANES OF THE SPINAL MARROW.

The spinal marrow has three coverings. The *dura mater* is a white fibrous membrane, and is external. It is continuous with that of the brain, and, investing the spinal marrow loosely, terminates at its inferior extremity in a pointed cul-de-sac. It does not adhere closely to the bony canal, except at the intervertebral foramina, where it affords sheaths for the nerves. Between it and the walls of the bony canal is a quantity of loose cellular tissue infiltrated with fat and serum.

The *arachnoid* is the middle covering. This is a serous membrane, investing the spinal marrow, and lining the inner surface of the dura mater, to which it gives a smooth, polished appearance. It is extremely thin and transparent, and destitute of red blood-vessels.

The *pia mater* is the immediate covering. This is a cellular membrane, consisting almost entirely of vessels. It terminates in a round cord-like process, which reaches from the end of the spinal marrow to the bottom of the canal, and is concealed in the roots of the nerves which constitute the *cauda equina*.

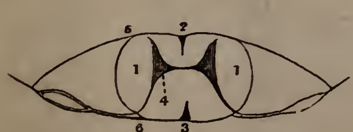
SPINAL MARROW.

The spinal marrow is the medullary column included in the spinal canal of the vertebræ. It is cylindrical, and reaching from the atlas, terminates in a point at the first or second lumbar vertebra. It is flattened anteriorly and posteriorly, and has an enlargement in the neck and loins. It is divided longitudinally into symmetrical portions, by an anterior and a posterior fissure. The anterior[2] fissure is broad and shallow; the posterior[3] is deep and narrow. Each half is divided unequally by a lateral fissure; the anterior column being the larger.[1]

A transverse section of the spinal marrow exhibits the arrangement of its medullary and gray matter. The medullary matter is external, and the gray, in this section, resembles two crescents united by a commissure.

The posterior horns[4] of the crescent extend to the surface in the lateral fissure, in which originates the posterior[6] roots of the nerves.

Fig. 140.



From the sides of the spinal marrow proceed 30 pairs of nerves, each originating by two roots; the anterior from the anterior column, and the posterior from the lateral fissure, where they connect with the poste-

rior horns. The posterior root is the larger, and upon it is a ganglion, which is in the invertebral foramen, beyond which the two roots unite. These two roots are separated by the *ligamentum denticulatum,* a pointed process of pia mater, which contains between its laminæ a good deal of yellow fibrous tissue.

MEMBRANES OF THE BRAIN.

The brain has three membranes, of which the most external is the *dura mater.* It is of the same structure as the dura mater of the spinal cord, composed almost entirely of white fibrous tissue. It consists of two laminæ, which are only separate at the points where the *sinuses* exist.

It adheres firmly to the bones of the cranium, particularly to those at the base of the skull. The internal lamina forms several processes. The *falx cerebri* is a fold of the internal lamina, reaching in the median line from the crista galli to the tentorium, and separating the two hemispheres of the brain. The *tentorium* is another fold, stretched horizontally, and also of a crescentic shape, separating the cerebrum from the cerebellum. The *falx cerebelli* is a smaller fold, reaching from the internal occipital cross to the foramen magnum, and separating the lobes of the cerebellum.

The *arachnoid* is the serous membrane covering the brain, and lining the inner surface of the dura mater. It is thin and transparent.

The *pia mater* is a vascular covering consisting of arteries and veins united by a small quantity of cellular tissue. It passes down in the fissures, between the convolutions, so as to invest them completely. The *Glands of Pacchioni* are generally small and white granulations, but sometimes are very large, especially in old persons. They are usually found along the margin of the longitudinal fissure, and may produce absorption of the dura mater.

THE BRAIN.

The brain consists of four principal parts: Medulla Oblongata, Pons Varolii, Cerebrum, and Cerebellum.

MEDULLA OBLONGATA.

This is the upper part of the spinal cord; it is conical in its shape, and extends from the atlas to the pons Varolii. It is divided by the anterior and posterior fissures symmetrically, and each half consists of three different parts.

Corpus pyramidale. — This is a narrow, cylindrical portion, resembling a cord, and situated in front. It communicates freely with its fellow, by a *decussation* of their fibres, about one inch from the pons.

Corpus olivare. — This is an oval, convex mass, behind and above

the corpus pyramidale, from which it is separated by a fissure. It is about half an inch in length. A section of it exhibits an arrangement of cineritious matter called *corpus fimbriatum.*

Corpus restiforme is the posterior division of each lateral column, and is separated from the corpus olivare by a groove. Between it and its fellow is a continuation of the posterior fissure called *calamus scriptorius,* across which pass transverse fibres of medullary matter, giving origin to the auditory nerve.

PONS VAROLII.

This is formed of medullary matter, and is cuboïdal in shape. Externally, the fibres are transverse; internally, they are longitudinal, being a continuation of those of the medulla oblongata. It is situated in front of the medulla oblongata, and rests upon the basilar process of the occiput. From it proceed *four crura.*

CEREBRUM.

The cerebrum is an oval mass, weighing from three to four pounds, and divided into two hemispheres by the superior longitudinal fissure. Each hemisphere consists of an anterior, middle, and posterior lobe. The anterior and middle lobes are separated by the fissure of Sylvius. The division between the middle and posterior, is an imaginary line in front of the anterior edge of the cerebellum. The surface presents a number of *gyri,* or convolutions, each separated by deep *sulci,* or fissures. The interior of each hemisphere is medullary, and the surface of each convolution is cineritious for the depth of one or two lines.

Island of Reil, is a cluster of radiated convolutions in the fissure of Sylvius.

Crura Cerebri, are two thick, cylindrical, white cords, which diverge from the anterior border of the pons, and their fibres terminate in the hemispheres of the brain. In a triangular space between them, is a layer of medullary matter called the *locus perforatus.*

Eminentiæ Mammillares, are two white, globular bodies, about the size of a pea, situated between the crura of the brain, and in front of the locus perforatus.

Tuber Cinereum, is a soft, gray mass, in front of the eminentiæ mammillares, and behind the chiasm of the optic nerves.

Infundibulum, is a hollow, conical body, of a reddish colour, with its base upon the *tuber cinereum,* and its apex attached to the *pituitary gland.*

Pituitary gland, is a vascular mass of a light colour, situated in the sella turcica. It consists of two lobes.

Corpus Callosum, is a white, arched band, seen at the bottom of the longitudinal fissure, forming a commissure between the two hemispheres. It is three inches and a half long, and about an inch broad. Its fibres are for the most part transverse, and consist of medullary

matter, with the exception of a few, which pass longitudinally, and are called the *raphé.*

Septum Lucidum, is a vertical partition, consisting of two laminæ, and separating the lateral ventricles. Its upper edge is in contact with the *corpus callosum,* and its lower with the *fornix.*

Fornix. — It is a triangular, medullary arch, whose base is continuous with the *corpus callosum* posteriorly, and whose apex divides into two crura, which terminate in the *eminentiæ mammillares;* its under surface is termed *lyra.* Under these crura is the *foramen of Monro,* by which the third and two lateral ventricles communicate.

Velum Interpositum, is a triangular reflection of pia mater, immediately under the fornix; its edges contain a plexus of veins called *plexus choroides.*

Pineal Gland, is a small, reddish-gray, conical body, situated upon the *tubercula quadrigemina,* and connected by two crura with the optic tubercles.

Tubercula Quadrigemina are four prominences situated over the junction of the pons and crura cerebri. Under them is a passage called aqueduct of Sylvius, or *iter e tertio ad ventriculum quartum.*

Corpus Striatum, a gray mass of an oblong shape, situated in the lateral ventricle on either side. It is medullary within.

Thalamus Opticus, is an oval, convex mass, behind the corpus striatum on each side. It consists of a mixture of medullary and gray matter, and the three prominences called *corpora geniculata,* one on either side, and one in front. It is connected with its fellow by some cineritious substance, called the soft commissure.

Tænia Striata, is a thin edge of medullary matter, in the groove between the corpus striatum and thalamus opticus.

Hippocampus major, is a scroll extending into the inferior cornu of the lateral ventricle, the extremity of which resembles a foot, and is called the *pes hippocampi.*

Corpus Fimbriatum or *Tænia Hippocampi,* is a thin edge of medullary matter upon the concave side of the hippocampus major; beneath which is a layer of cineritious matter, having a serrate appearance, and called the *fascia dentata.*

Hippocampus Minor, or *Ergot,* resembles a cock's spur; is a conical elevation pointing backwards into the *posterior cornu.*

Ventricles of the Brain.—These are five in number. They are called the *right* and *left lateral,* the *third, fourth,* and *fifth ventricles.*

Lateral ventricles exist in each hemisphere, and contain the *corpus striatum* and *thalamus opticus.* Each communicates with the third and its fellow by the foramen of Monro, being separated partially by the *septum lucidum;* the roof is formed by the corpus callosum. It contains three angular depressions called *cornua;* the anterior contains nothing; the posterior, the hippocampus minor; and the inferior, the hippocampus major.

The third ventricle is the space between the *thalami optici.* Its

roof is formed by the velum interpositum and fornix, and its floor by the locus perforatus and the tuber cinereum. It is traversed in front by the anterior commissure, a medullary cord extending between the *corpora striata*, and by the posterior commissure, which extends transversely between the *thalami optici.* It communicates with the lateral ventricles by the foramen of Monro, and with the fourth by the aqueduct of Sylvius.

The fourth ventricle is situated between the pons Varolii, cerebellum, and medulla oblongata. Its floor is the calamus scriptorius, and its roof is the *valve of the brain.* Laterally and posteriorly, it is limited by the pia mater and the arachnoid. It communicates with the third.

The fifth ventricle is situated between the laminæ of the septum lucidum. It does not communicate with the other ventricles.

CEREBELLUM.

This constitutes about one-sixth of the brain, and is contained between the occiput and tentorium. It is oblong and flattened: its greatest diameter being transverse. It is composed of white and gray substances, the latter of which is external, and apparently arranged in laminæ. It is divided by a longitudinal fissure into two lobes; the superior part of which fissure contains a ridge called *vermis superior,* in advance of which is an elevation called *monticulus.* In the inferior part of this fissure is a smaller ridge called the *vermis inferior.*

At the root of the crura cerebelli are two small protuberances; the one below it, in the erect position, is the *lobulus nervi pneumogastrici,* and the other the *lobulus amygdaloides.*

The valve of the brain is a thin *white lamina,* extending from the inferior surface of the cerebellum to the *corpora restiformia.*

Arbor vitæ, a section of either lobe of the cerebellum, presents an arborescent arrangement of the medullary matter.

Corpus Dentatum, or *Rhomboideum,* is a name applied to a gray mass with serrated edges, in the trunk of this medullary tree.

CRANIAL NERVES.

These are nine in number, and are so called from their emerging through the foramina, at the base of the cranium. They are designated by their function, as well as numerically. Their origin is as follows:

1st. *Olfactory.*—Arises by three roots, which coalesce in the fissure of Sylvius.

2d. *Optic.*—Arises from the thalamus opticus and the tubercula quadrigemina.

3d. *Motor Oculi.*—Arises from the crus cerebri.

4th. *Patheticus.*—Arises from the valve of the brain.

5th. *Trifacial.*—Arises from the superior and posterior part of the pons Varolii.

6th. *Motor Externus.*—Arises from the corpus pyramidale.

7th. *Facial and Auditory.*—The facial or *portio dura* arises in a groove between the corpus olivare and corpus restiforme near the pons Varolii. The auditory or *portio mollis* arises from transverse striæ upon the calamus scriptorius. The *portio intermedia* of the 7th arises in the corpus restiforme, and may be considered as the posterior or sensitive root to the facial.

8th. *Pneumogastric, glosso-pharyngeal, and spinal accessory.*—The first two arise by filaments from the fissure between the corpus olivare and the corpus restiforme; and the last arises from the spinal cord by a series of slender roots, as low down as the fourth or fifth cervical vertebra.

9th. *Hypoglossal.*—Arises in the fissure between the corpus pyramidale and corpus olivare.

The cranial nerves may be divided into three classes, according to their function, viz.:—*Nerves of special sense*, including the 1st, 2d, and the auditory branch of the 7th. *Nerves of motion*, including the 3d, 4th, 6th, facial branch of the 7th and 9th. *Compound nerves*, comprising the 8th and 5th.

The distribution of the cranial nerves—

1st. *Olfactory.*—It has a large, soft bulb, which rests on the cribriform plate of the ethmoid bone, and sends filaments through its foramina to the Schneiderian membrane.

2d. *Optic.*—Forms a chiasm with its fellow, and enters the globe of the eye through the foramen opticum, to join the retina. It is a flattened cord.

Fig. 141.

3d. *Motor Oculi.*[3] — Passes through the external wall of the cavernous sinus to escape at the sphenoidal foramen, and then is distributed upon the muscles of the eyeball, with the exception of the superior oblique and external rectus. It sends a *branch* to join the ophthalmic ganglion, from which proceed the ciliary nerves,[8] which supply the iris.

4th. *Pathetic.*[4]— Passing through the external wall of the cavernous sinus, and through the sphenoidal foramen, it is distributed upon the superior oblique muscle of the eyeball. It is the smallest cranial nerve.

5th. *Trifacial.*—The trifacial or trigeminus[5] (Fig. 142), the largest of the crenial nerves, has a fibrous appearance. It resembles the spinal nerves in arising by two roots, which can be traced into the anterior

and posterior columns of the spinal marrow, and also in having a ganglion upon its posterior and larger root.

This ganglion, called Casserian,[6,7,8] rests upon the depression upon the anterior portion of the petrous portion of the temporal bone. From it proceed three large branches, called ophthalmic, superior maxillary, and inferior maxillary nerves. The first and second branches confer sensibility on the structures on which they ramify; but the third receives the motor filaments of the anterior root, and, therefore, confers motion as well as sensibility to the structures upon which it is distributed.

The *ophthalmic*[6] passes out through the sphenoidal foramen into the orbit by three branches, the nasal, frontal, and lachrymal. The *nasal*[11] gives off the *internal nasal*, which enters the cranium at the anterior ethmoidal foramen, and then goes through the cribriform plate into the nose; and also a branch (*ramus ciliaris*) to the lenticular or ophthalmic ganglion. The nasal is distributed to the muscles of the orbit, eyelids, and conjunctiva. The *frontal*[9] divides into two branches, and is spent upon the integuments and muscles of the forehead; one branch goes through the supra-orbitary foramen. The *lachrymal*[10] branch supplies the lachrymal gland, and the contiguous portions of the orbit.

Fig. 142.

The *superior maxillary*[7] passes through the foramen rotundum, and then enters the pterygo-maxillary fossa.[20] A large branch called *infra orbital*[15] traverses the infra-orbital canal, and emerges at the infra-orbital foramen[19] to supply the face; giving off the *dental nerves*[16,17] in its course. The *pterygo-palatine branch*, or branches, join the *ganglion of Meckel* in the pterygo-maxillary fossa, from which proceed the spheno-palatine branches, which enter the nose through the spheno-palatine foramen; one of these branches is long, and called naso-palatine, which joins its fellow at the ganglion of Cloquet in the *foramen incisivum;* the posterior palatine descends from the ganglion through the posterior palatine foramen, and is distributed to the palate and fauces; the *vidian*, or *pterygoid*, or *recurrent*,[21] passes backwards from the ganglion through the pterygoid foramen, and divides into two branches, called *superficial* and *deep petrous.* The superficial

petrous enters the *hiatus Fallopii*, and passing between the smaller bones of the ear, emerges at the Glaserian fissure under the name of *chorda tympani*, which joins the submaxillary ganglion. Some anatomists deny the continuity of this branch of the vidian with the chorda tympani nerve, and consider the former as blending itself with the portio dura, and the latter as arising from the same part of the seventh nerve. The deep petrous enters the carotid canal, and joins the ganglion of *Laumonier*, which was formerly considered the origin of the sympathetic nerve.

The *inferior maxillary*,[8] is the largest branch of the 5th pair. It is composed of filaments from the Casserian ganglion, and of the anterior or motor root of the tri-geminus. It emerges from the cranium through the foramen ovale, and soon divides into two principal trunks which are separated from each other by the external pterygoid muscle. The *external* trunk is composed mostly of the motor filaments,[22] and splits into five branches, which are distributed to the masseter, buccal, pterygoid, and temporal muscles. One of the temporal branches perforates the temporal fascia and communicates with the auricular and facial nerves. The internal trunk gives off three branches, viz., the gustatory, superficial temporal, and inferior dental.

The *gustatory*,[3] passes between the pterygoid muscles, and then curves forward above the sublingual gland and beneath the mylo-hyoid muscle and parallel to the stylo-glossus muscle. — It accompanies the Whartonian duct, and is distributed to the papilla and mucous membrane upon the sides and tip of the tongue.

The chorda tympani nerve joins it near the condyle of the lower jaw, and parts from it near the angle, to join the submaxillary ganglion, whose branches pass into the submaxillary gland.

The *superficial temporal*,[27] or auriculo-temporal, often commences by two roots, between which passes the meningea magna artery. From it proceed several branches, to the parotid gland, to the joint, to the external ear, and to the side of the head, in company with the branches of the temporal artery.

The *inferior dental*[24] descends between the pterygoid muscles, and enters the posterior mental foramen after having given off the *mylo-hyoidean* branch to the muscle of the same name. It then runs along the canal in the lower jaw, supplying the teeth, and sends a branch through the anterior mental foramen, which is distributed upon the chin.

The *otic ganglion*, a small, reddish-gray body, is situated upon the inferior maxillary nerve, near its emergence from the foramen ovale.

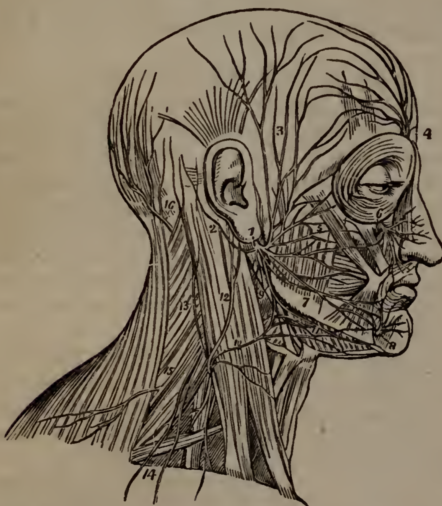
6th. *Motor Externus.* — Passing through the cavernous sinus, it escapes from the cranium through the sphenoidal foramen or fissure, and is distributed to the external rectus muscle of the eyeball. Its paralysis will produce an internal squint. A branch enters the carotid canal to join the ganglion of Laumonier.

7th. *Facial and auditory.*—Both branches enter into the internal meatus; the auditory is also called *portio mollis*, and is distributed to the internal ear. The facial, also called *portio dura*, passes through

the aqueduct of Fallopius, where it is joined by the superficial petrous, and emerges from the temporal bone at the stylo-mastoid foramen.[1] (Fig. 143.)

Before it enters the parotid gland, it gives off the posterior auricular,[2] digastric, and stylo-hyoid branches. As it passes through the gland a plexus is formed, called the pes anserinus, from which proceed two principal branches, viz., the temporo-facial[3] and cervico-facial. The temporo-facial[3] is distributed by temporal, buccal, and malar branches, to muscles of the face; the cervico-facial[7] is distributed by branches to the muscles upon the lower jaw and neck, which communicate with the cervical nerves.

Fig. 143.



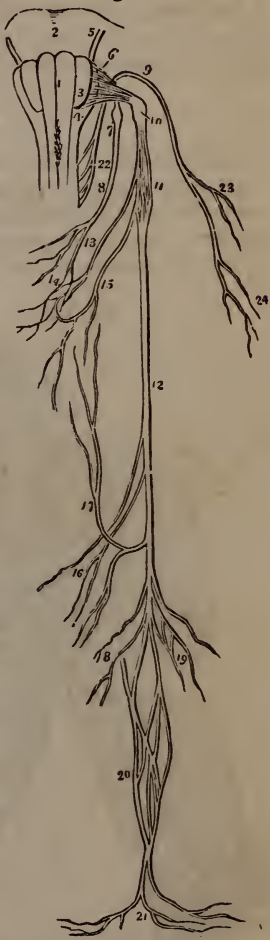
The 8th consists of three branches, the *glosso-pharyngeal*, the *pneumo-gastric*, and the *spinal accessory*, all of which emerge from the cranium at the posterior foramen lacerum or jugular foramen. (Fig. 144.)

The *glosso-pharyngeal* is the highest branch of this nerve. It passes out of the cranium by a distinct fibrous canal in the foramen, and descends between the internal jugular vein and the carotid artery in a curved line, adhering to the stylo-pharyngeus muscle. It is deeper in the neck, and below the gustatory nerve. Upon it are two ganglions — one is in the jugular foramen, and involves only a part of the nerve; and the other is the petrous or *Anderschian ganglion.*[7] From it arises numerous branches, which communicate with the facial, the sympathetic, and the pneumo-gastric, and also the filament called *Jacobson's nerve.* This nerve enters the tympanum through a small opening between the jugular and carotid foramina, to form the *plexus* upon the inner wall of the tympanum, in which the 5th pair and the sympathetic communicate.

From the glosso-pharyngeal are given off branches, which with others from the sympathetic and pneumogastric form the *pharyngeal* plexus.[14] It supplies the papillæ at the posterior part of the tongue and the mucous membrane of the pharynx, and also some of the muscles of the tongue and pharynx.

The *pneumogastric* having escaped from the cranium by the posterior foramen lacerum, or jugular foramen, presents a ganglionic enlargement [11] called *plexus gangliformis*. A small ganglion [10] is also found upon that portion which passes through the foramen. It then descends within the sheath of the vessels of the neck, lying behind and between the artery and vein, and entering the thorax and abdomen, supplies the lungs and stomach, giving off the following branches: the *superior pharyngeal*,[12] which assists in forming the pharyngeal plexus,[14] assisted by branches from the glosso-pharyngeal, the superior laryngeal, and sympathetic. This plexus is distributed to the muscles and mucous membrane of the pharynx.

Fig. 144.



The *superior pharyngeal* [15] arises from the ganglionic plexus, enters the larynx, and is distributed to its mucous membrane. The *cardiac* branches [16] are two or three in number, and descend to join the cardiac plexus. The *inferior laryngeal*,[17] or *recurrent laryngeal*, curves around the aorta upon the left side, and the subclavian upon the right; ascending between the trachea and the œsophagus, it is distributed to the muscles of the larynx, communicating with the superior laryngeal and the sympathetic nerve. *Anterior* and *posterior* [18] [19] *pulmonary* branches are given off in the thorax to form the pulmonary plexus. The *œsophageal branches* [20] surround the œsophagus, and with it enter the abdomen through the diaphragm, there to be spent upon the stomach and neighbouring viscera, and also to communicate with the solar plexus.

Spinal accessory.—This branch [9] of the eighth pair escapes also at the jugular foramen, and divides into two branches, one of which gives filaments to the superior pharyngeal nerve; the other, which is the larger, descends obliquely backwards, and piercing the sterno-mastoid muscle, is distributed to the trapezius, after having communicated with the upper cervical nerves.[23 24]

9th. The *Hypoglossal nerve* emerges from the cranium through the anterior condyloid foramen; it then passes between the internal carotid

artery and internal jugular vein, and curving around the occipital artery, sends branches to the muscles of the tongue. A branch, *descendens noni*, descends as a long, thin filament, in front of the sheath of the vessels, and below the middle of the neck; forming a loop with a branch from the second and third cervical nerves. It communicates with the pneumogastric and sympathetic.

SPINAL NERVES.

There are thirty pairs of spinal nerves, each arising by two roots.

After the union of the anterior or motor root with the posterior or sensitive root in the intervertebral foramen, the spinal nerves divide into two trunks, the *posterior* of which are much the smaller, and supply the muscles of the back; the *anterior* are large, and communicating with the ganglions of the sympathetic nerve, form plexuses which give off the principal nerves to the muscles of the trunk and extremities.

Fig. 145.

CERVICAL NERVES.

These are eight in number: the first is called the *sub-occipital;* it passes out of the spinal canal between the occiput and atlas, in a groove beneath the vertebral artery. It supplies the recti muscles, and unites with the first cervical so as to form a loop around the transverse process of the atlas. (Fig. 143.)

Three superior cervical nerves anastomose freely and form a *cervical plexus,* which sends numerous branches to the muscles and skin of the neck, forming communications with the ninth and facial nerves. The principal branches from this plexus are the superficial (Fig. 143),[10 12] the great auricular,[13] the occipital,[16] and the supra-clavicular.[15]

The *phrenic* nerve[1 6] (Fig. 145), is formed by filaments from the second and third cervical nerves, and passing over the scalenus anticus muscle, and through the anterior mediastinum, adheres to the pericar-

dium. It is distributed to the diaphragm by several branches. The right passes in front of the innominata, the left passes in front of the aorta, and is more deeply situated than the right in the thorax.

The *four inferior cervical* nerves, together with the first dorsal, emerging from the spinal canal between the scalenus anticus and medius muscles, form a large plexus, by their anterior branches, which is plaited around the subclavian and axillary arteries.

The *brachial plexus* gives off the following branches: the *supra scapular* branch, which ascends upon the shoulder and supplies its muscles; passing through the coracoid notch.

The *Posterior* or *long thoracic branch*[1] is distributed to the serratus anticus muscle. (External respiratory nerve of Bell.)

The *sub-scapular* branches are two in number, and supply the subscapular muscle.

The *anterior* or *short thoracic* are two in number, and supply the pectoral muscles.

The lesser internal cutaneous, or nerve of Wrisberg, is distributed to the skin of the upper and posterior part of the arm. It is frequently joined by the first intercosto-humeral nerve.

The *circumflex* or *axillary* nerve winds round the head of the humerus, in company with the posterior circumflex artery, and is distributed to the deltoid muscle. The *internal cutaneous* is a very small, thin filament passing down the inside of the arm, and sends branches across the superficial veins at the elbow, then is distributed to the skin, fascia, and fore-arm. The *external* or *musculo-cutaneous*[4] perforates the coraco-brachialis, and is also distributed to the muscles in front of the arm and integument of the fore-arm.

The *ulnar*,[3] descending the arm, passes superficially under the internal condyle, and is finally distributed to the little finger, and the ulnar side of the ring-finger.

The *radial* or *musculo-spiral* is the largest of these nerves which come from the brachial plexus; it winds around the humerus, between the head of the triceps muscle, which it supplies with branches, and then descends the fore-arm, supplying its muscles; a large branch accompanies the radial artery, supplying the wrist and thumb.

The *median*[2] descends the arm in close company with the brachial artery, until it reaches the elbow; it there passes between the two heads of the pronator teres muscle, and descending the fore-arm, between the flexor sublimis and profundus muscles, it is distributed to the fingers, with the exception of those supplied by the ulnar.

DORSAL NERVES.

These are twelve in number; the anterior branches are the larger, and are received into the intercostal grooves, in which they run, to be distributed to the muscles of the chest.

The *first dorsal nerve* joins the brachial plexus. The *intercosto-humeral nerves*[5] are two in number; they proceed from the second and

third dorsal nerves, and perforate the second and third intercostal spaces, to be distributed upon the skin of the arm; the first frequently joins the nerve of Wrisberg.

LUMBAR NERVES.

These are five in number; the anterior branches of the four superior descending form the *lumbar plexus*, which is situated behind the psoas magnus muscle; it is frequently connected with the last dorsal nerve.

The *abdomino-crural*[3] branches are two or three in number, and pass obliquely over the quadratus lumborum muscle, and supply the muscles of the abdomen and the skin of the groin and genitals.

Fig. 146.

The *external cutaneous*[4] crosses obliquely the iliacus internus muscle, towards the anterior superior spinous process. It perforates the fascia lata, and is distributed to the integument of the thigh.

The *external spermatic*[9] or genito-crural perforates the psoas muscle, and descending to the groin, supplies the cremaster muscle and skin of the thigh.

The *anterior crural*[8] is the largest branch of the lumbar plexus. It emerges from under the psoas magnus muscle and passes under Poupart's ligament. It gives off the *anterior*, *middle*, and *internal cutaneous* branches,[5,6,7] which are distributed to the integuments; the *long*, or *internal*, or long *saphenous* nerve, accompanies the femoral artery as far as its perforation of the adductor tendon, and then accompanies the saphena vein to the foot.

The *obturator* accompanies the obturator artery, and emerges from the pelvis at the upper portion of the thyroid foramen. It is distributed upon the obturator and adductor muscles.

SACRAL NERVES.

These are five and sometimes six in number; the anterior trunks

of the four upper, with a portion of the last dorsal, constitute the *sacral plexus.* The fifth and sixth are distributed to the gluteus maximus muscle, and to the skin. The sacral plexus is triangular in its shape, and situated upon the pyriformis muscle. From it are derived a few small branches sent to the muscles and viscera of the pelvis, and also the following nerves to the lower extremity.

Fig. 147.

The *gluteal,*[1] which, emerging from the sacro-sciatic notch, divides into two large branches to supply the glutei muscles. (Fig. 147.)

The *pudic,*[2] or *superior long pudendal,* accompanies the internal pudic artery, and supplies the perineum, and organs of generation; it divides into two branches, the *superior* continuing to the extremity of the penis with the dorsal artery.

The *lesser ischiatic*[3] escapes from the pelvis between the pyriformis muscle and the great sacro-sciatic ligament, and divides into the *inferior long pudendal* or *perineal,*[5] which winds around the tuberosity of the ischium, and is distributed to the integuments of the perineum; and the *posterior cutaneous,*[6] a long filament passing down the back of the thigh and leg, to be spent upon the integuments.

The *great sciatic*[7] is the largest nerve in the body; it escapes from the pelvis beneath the pyriformis muscle, and descends the back of the thigh between the flexor muscles; about one-third above the knee, it divides into two large branches, called *peroneal* and *popliteal.*

The *popiteal*[8] descends through the popliteal space, giving off numerous muscular and cutaneous branches, one of which, the *external* or short *saphenous nerve,*[10] is joined by the internal peroneo-cutaneous nerve,[11] and becomes superficial near the ankle; it then passes behind the external malleolus, and supplies the skin, external malleolus, and the foot.

The *posterior tibial*[9] is a continuation of the popliteal, descending the back of the leg

in company with the posterior tibial artery; it is finally distributed upon the sole of the foot by two branches called the *external* and *internal plantar* nerves.

The *internal plantar* is the larger, and is distributed to the first, second, and third toes, and to the inner side of the fourth.

The *external plantar* is distributed to the little toe, and the outer side of the next toe.

The plantar nerves are distributed to the toes upon the same plan as the median and ulnar nerves are to the fingers.

The *peroneal nerve* extends towards the head of the fibula, passing between the external side of the tendon of the biceps and the outer part of the external head of the gastrocnemius. It gives off the following cutaneous branches, and then divides into the external peroneal and anterior tibial. The *internal peroneo-cutaneous* is the largest cutaneous branch; it joins with the external saphenous or *communicans tibiæ.*

The external peroneo-cutaneous is distributed to the skin along the fibula.

The *external peroneal* passes down the fibular side of the leg, through the peroneus longus muscle, and becoming superficial in the lower third of the leg, perforates the crural fascia, and is distributed to the integuments of the foot and ankle.

The *anterior tibial* descends in front of the interosseous ligament, in company with the anterior tibial artery, and is distributed to the muscles of the leg, and to the muscles and skin upon the foot.

SYMPATHETIC NERVE.

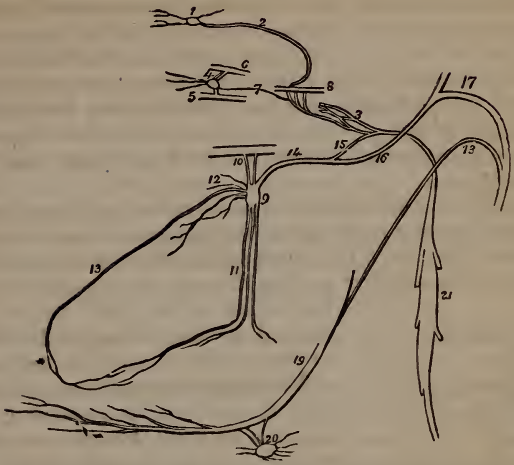
The sympathetic system consists of two chains of ganglia, united to each other and to the cranial and spinal nerves. Each ganglion may be considered as a distinct nervous centre, and is placed opposite the intervertebral space. The two sides of the sympathetic system are united in the head by the ganglion of Ribes, which may be considered as the origin of the sympathetic nerve. There is also a ganglion in the median line of the coccyx, whereby the two lateral halves of the sympathetic are united below.

It is distributed in connexion with all the other nerves of the body, and by means of plexuses supplies all the internal organs; these plexuses take the name of the artery with which they are connected, or of the organ to which they are distributed.

The *cranial* ganglia of the sympathetic are five in number, viz.:

The *ganglion of Ribes*,[1] which is small, and situated upon the anterior communicating artery; a filament of it[2] joins the sixth nerve,[8] which communicates with the carotid plexus.[3] The *carotid plexus* surrounds the carotid artery in the carotid canal, and frequently contains a ganglion called after *Laumonier.* This plexus is joined by the *deep petrous* branch of the vidian nerve, and was formerly considered the origin of the sympathetic.

Fig. 148.



The *lenticular* ganglion[4] is small and flattened, reposing between the optic nerve and the external rectus muscle. This ganglion communicates with a branch of the nasal nerve,[6] and a branch of the third, called ciliary;[5] a small filament[7] passes from this ganglion to join the carotid plexus.

The *spheno-palatine* ganglion is called also *Meckel's* ganglion.[9] From this are given off the vidian nerve,[14] the deep petrous branch of which joins the carotid plexus, as has been mentioned, and the superficial petrous,[16] which enters the hiatus Fallopii, and emerging at the Glaserian fissure as the chorda tympani,[12] descends in connexion with the gustatory nerve[19] to join the *submaxillary ganglion.*

The *ganglion of Meckel* communicates with the superior maxillary nerve by means of its two ascending branches, called *pterygo-palatine.*[10] One of its spheno-palatine branches,[12] called naso-palatine,[13] joins its fellow in the foramen incisivum, to form the ganglion of Cloquet,* or naso-palatine ganglion. Its descending branches[11] supply the palate, gums, and fauces.

The *otic* ganglion (Arnold's), is a small oval ganglion, adhering to the inner surface of the inferior maxillary nerve, below the foramen ovale; it sends branches of communication to the superior and inferior maxillary, to the vidian and tympanic nerves, and it also supplies the tensor tympani and the tensor palati muscles.

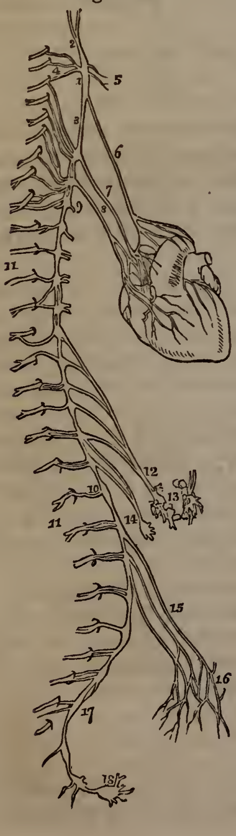
CERVICAL GANGLIA

Are three in number. The *first*[1] (Fig. 149) is a long, gray, spindle-shaped ganglion, extending to the lower border of the third cervical

vertebra, behind the sheath of the vessels of the neck. Its branches are numerous, and some are very soft, hence termed *nervi molles.* They communicate with the anterior trunks[4] of the first, second, and third cervical nerves; and by an ascending branch[2] with the carotid plexus, and by a descending branch[3] with the second cervical ganglion. Its internal branches[5] join the facial, eighth, and ninth nerves, and the pharyngeal plexus. A number of branches join to form the *superior* cardiac nerve,[6] which descends behind the vessels and joins the cardiac plexus.

The *middle cervical* ganglion is usually small, and sometimes wanting. It rests upon the inferior thyroid artery in front of the fifth or sixth cervical vertebra. It is often called the *thyroid* ganglion. Its branches join the superior and inferior cervical ganglia, and the anterior trunks of the third, fourth, and fifth cervical nerves; it also sends the *middle cardiac nerve*[7] to join the cardiac plexus.

Fig. 149.



The *inferior cervical ganglion* is larger than the last, and is situated in front of the root of the transverse process of the seventh cervical vertebra. Its filaments join the sixth, seventh, and eighth cervical nerves, and also form the *inferior cardiac* nerve, which joins the middle cardiac nerve and the cardiac plexus.

The *cardiac plexus* is situated behind the arch of the aorta, upon the bifurcation of the trachea. Its branches, in conjunction with the par vagum and descendens noni, form the anterior and posterior cardiac plexuses; from these plexuses are derived the filaments which supply the heart.

THORACIC GANGLIA.

These are twelve in number, situated at the intervertebral spaces. They are small and connected with each other, as well as with the anterior trunks of the spinal nerves. The great *splanchnic*[12] is formed by filaments from the sixth to the tenth ganglion; it descends in the posterior mediastinum, and pierces the diaphragm at or near the foramen aorticum, to form the semilunar ganglion. The *lesser splanchnic nerve*[14] is formed by filaments from the tenth and eleventh ganglia; it pierces the diaphragm and joins the semilunar ganglion and the renal plexus.

The *semilunar ganglion*[13] consists of a number of smaller ganglia formed upon filaments of the splanchnic nerve after it has entered the abdomen; they are arranged in a crescentic manner,[13] and situated upon the aorta and cœliac axis.

The *solar plexus* is a network on the sides of the aorta, and extends as far as the renal arteries. It is a number of filaments connecting the portions of the semilunar ganglia; and from it proceed smaller plexuses, which accompany the large arterial trunks; thus, the *hepatic plexus* is the network which surrounds the hepatic artery, and is distributed to the liver, gall-bladder, &c. The *splenic plexus* accompanies the splenic artery and supplies the spleen; thus also, are distributed the renal, mesenteric, and other plexuses.

LUMBAR AND SACRAL GANGLIA.

The *lumbar ganglia* are four or five in number, which are united with each other and the spinal nerves. They form a plexus upon the aorta, which receives filaments from the solar and hypogastric plexuses.

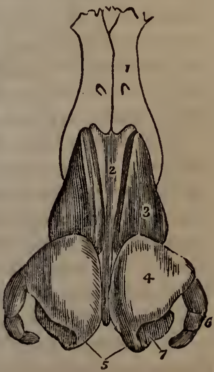
The *hypogastric plexus*[16] is formed by branches of the lumbar[15] and aortic plexuses and filaments from the *sacral ganglia.* From it are supplied all the viscera of the pelvis. The sacral ganglia are three or four in number. The last is called *impar*[18] or *azygos,* and is situated in the median line of the coccyx, and constitutes the *terminating ganglion* of the sympathetic.

SECTION VII.

ORGANS OF SENSE.

NOSE.

Fig. 150.



The nose consists of two portions, an external projection upon the face, and an internal cavity.

The *external* portion is formed by the nasal processes of the superior maxillary bones, the nasal bones,[1] and by five cartilages, two of which are placed upon either side and one in the middle. The *cartilaginous septum* is placed in the median line;[2] it is thick, flat, and triangular, uniting by its superior edge with the ethmoid, and by its inferior edge with the vomer. Its anterior edge unites with the *lateral* and *alar* cartilages. It frequently deviates from the median line. The *lateral* cartilages[3] are triangular, one being placed on either side, attached above and behind to the bone, in front with the septum, and below with the alar cartilage. The *alar* car-

tilages[4] are two in number; they form the lower portion of the nose, and the opening called the nostril. It is an irregular, semi-elliptical cartilage, and has a number of small pieces of cartilage attached to it, by which the nostril is kept open. These cartilages are held together by a fibrous tissue. The skin which covers the nose is thick and strong, and covered with numerous sebaceous follicles, which are frequently recognised by their being discoloured. The hairs visibl in the nostril are termed *vibrissæ.*

The *cavity* of the nose is formed by the nasal fossæ. The roof is the cribriform plate of the ethmoid, the floor is the hard palate. Upon each side there are three scrolls formed by the turbinate bones. Between the superior and middle turbinate bones is the *superior meatus;* between the middle and inferior turbinate bones is the *middle meatus;* between the inferior turbinate bone and the floor of the nose is the *inferior meatus.*

The nose is lined by a mucous membrane, called *pituitary* or *Schneiderian,* which is thick, soft, and red, owing to its vascularity, and largely supplied with nerves, being the seat of smell. This membrane lines the meatuses of the nose, and is continuous with the mucous membrane of the mouth, lachrymal canal, Eustachian tube, frontal sinus, and ethmoidal cells. It is supplied by the first and fifth pairs of nerves, and by branches of the internal maxillary artery.

THE EYE AND ITS APPENDAGES.

The *eyeball* (Fig. 151) is a sphere, about one inch in diameter, antero-posteriorly, and rather less transversely. It is surrounded by a fibrous capsule, which is continuous with the sheath of the optic nerve behind, and the cartilages of the eyelids in front. All the muscles of the ball of the eye lie behind the capsule or fascia, and perforate it, in order to be inserted into the sclerotic coat.

The *sclerotic coat*[1] is a dense, fibrous, white membrane, thinner in front, where it receives the cornea, than it is behind, where it is perforated by the optic nerve. The circular edge in contact with the cornea is bevelled. The external surface is anteriorly covered by the *conjunctiva,* and posteriorly by fat. Its internal surface is connected with the choroid coat. It is perforated by numerous small foramina transmitting arteries and nerves.

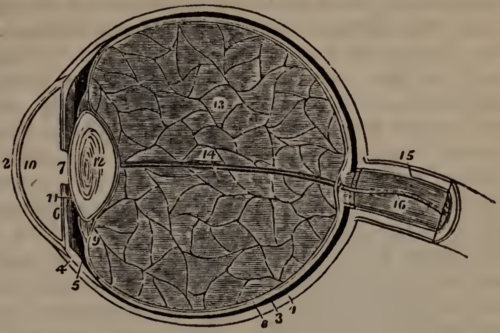
The *cornea*[2] fills up the opening in the anterior part of the sclerotica, and forms about one-sixth of the whole eyeball; it is more convex than the sclerotica, and therefore forms a projection in front. It is a transparent and apparently homogeneous tissue, but is in fact composed of numerous laminæ, between which there is a slight quantity of fluid. It is covered anteriorly by the conjunctiva, and posteriorly by the epithelium of the aqueous humour.

The *canal of Fontana* is a venous sinus, near the border of the cornea.

The *choroid coat*[3] is a thin, vascular tunic of the same extent as the sclerotica, with which it is in contact externally. It is filled with a

black colouring matter called *pigmentum nigrum*, and consists principally of arteries and veins. It is traversed by several nerves. Its in-

Fig. 151.

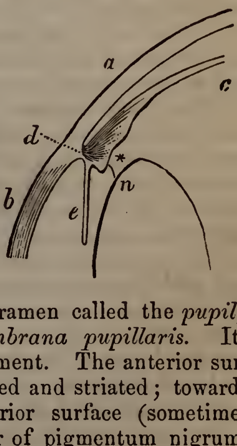


ternal layer is composed principally of arteries, and called *membrana Ruyschiana;* externally it is composed principally of veins, called *vasa vorticosa.*

The *ciliary ligament*[4] is a flat, gray, delicate ring, at the junction of the cornea and sclerotica, which unites the external border of the iris and the ciliary body.

The *ciliary body*[5] is formed by the anterior portion of the choroid coat, in contact with the ciliary ligament, and from it proceed seventy or eighty short folds, called *ciliary processes*, which converge and are smaller behind than they are in front; they surround the lens.

Fig. 152.



The *ciliary muscle* is a small, gray structure, behind the ciliary ligament,[d] and covering the outside of the ciliary processes. Its contraction presses the lens[n] towards the cornea.[b] (Fig. 152.)

The *iris* (Fig. 151) is a thin, circular membrane,[6] consisting of contractile tissue, and forming a vertical septum between the anterior and posterior chambers of the eye. It is perforated nearly in the centre by a foramen called the *pupil*,[7] which in fœtal life is closed by the *membrana pupillaris.* Its external border is attached to the ciliary ligament. The anterior surface is flat, of a bluish or brown colour, speckled and striated; towards the pupil the colour is deeper. Its posterior surface (sometimes called the *uvea*) is covered with a thick layer of pigmentum nigrum, and is in contact with the ciliary processes. It may contain a few muscular fibres in its structure. It is supplied by the ciliary arteries,

branches of the ophthalmic, and by the ciliary nerves, which pass from the lenticular ganglion, through the choroid coat to be distributed upon it.

The *retina*,[8] is a soft, white membrane, within the choroid coat, and is considered by some to be an expansion of the optic nerve, and by others as a distinct nervous structure in connexion with the optic nerve. Internally it is in contact with the vitreous humour. It commences at the optic nerve, and terminates anteriorly by a jagged edge, called *ora serrata*, behind the ciliary body. It is thicker behind than it is in front. When perfectly fresh it has a pinkish tint, and is semi-transparent. Its inner surface is of a fibrous character, consisting of radiating tubular fibres of the optic nerve. Its external surface consists of a finely-granulated matrix, interspersed with very delicate vessels. The *optic nerve*,[15] enters the globe of the eye on the inner side of its axis, and the point where it is connected with the retina is incapable of vision. Directly in the axis there exists upon the retina the yellow spot of *Soemmering*, a slight elevation with a minute perforation in its summit. The central artery of the retina enters through the optic nerve, and traversing the vitreous humour, supplies the retina and lens.

Membrana Jacobi.—Is a thin lamina, existing between the choroid and the retina, consisting of a number of club-shaped rods, interspersed with transparent cells.

The *vitreous humour*[13] has a transparent, jelly-like appearance, and is of a globular form. It consists of a viscous fluid, held in cells formed from the hyaloid membrane, which surrounds it. It is colourless, and its structure is best exhibited by freezing.

The *canal of Petit*,[9] is formed between the laminæ of the hyaloid membrane, and surrounds the edge of the lens.

The *zone of Zinn*, is a circle of plaitings upon the vitreous humour, which dovetail with the ciliary processes.

The *Crystalline lens*[12] is a double convex lens, whose posterior surface is more convex than its anterior. In childhood it is spherical, and in old age it is flattened. It is transparent and soft, and surrounded by a capsule which contains a thin fluid, called *liquor Morgagni*. It consists of concentric laminæ, having a tendency to divide into three equal segments.

The *aqueous humour*[10] is a transparent fluid, occupying the anterior and posterior chambers of the eye, bathing the posterior surface of the cornea, and the anterior surface of the capsule of the lens. It is from four to five grains in quantity. This is said to be secreted by the membrane of Demours, which lines the whole of the anterior and posterior chambers. This membrane can only be traced upon the posterior surface of the cornea.

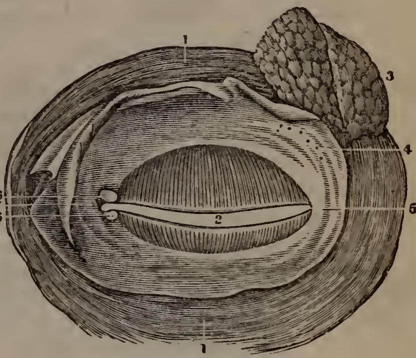
The *eyebrows* are two elevations of the skin covered with short, stiff hairs, protecting the eye from too strong a light, and from the perspiration flowing down the forehead; they materially affect the

expression of countenance. The space between the two is called *glabella.*

The *eyelids* or *palpebræ,* consist of skin, muscular fibres, cartilage, and mucous membrane; and when in contact, leave a triangular canal, which passes transversely between them. Their edges are covered with *cilia,* or eyelashes, which are short, stiff, curved hairs, protecting the eyeball.

Tarsal cartilages.[2]— Are two in number. That of the upper lid is larger than that of the lower; they are crescentic in shape, and attached by the external and internal palpebral ligaments.

Fig. 153.



Conjunctiva.[4]—Is a soft mucous membrane lining the lids, and covering the anterior surface of the ball, forming a fold called *plica semilunaris,* near the inner canthus. It is vascular, and well supplied with nerves.

Meibomian glands. — Are twenty or thirty small yellow thread-like glands between the conjunctiva and the posterior surface of the lids, discharging by numerous orifices along the edges of the lids a viscid fluid which prevents the overflow of tears at night.

Caruncula lachrymalis.[7] — A small, red elevation, in the internal canthus, about the size of a grain of wheat; consisting of an aggregation of small sebaceous glands, and often furnished with hairs.

Lachrymal gland.[3]—A lobulated gland, about the size of a filbert, and of a light pink colour, situated in a fossa on the roof of the orbit, near the external angular process. It consists of two portions, viz., orbital and palpebral. It discharges tears by ten or twelve ducts,[4] whose orifices open upon the upper and outer part of the conjunctiva.

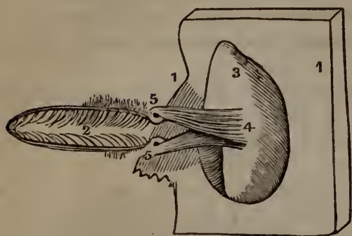
Lachrymal canals. — These open by small orifices, called *puncta lachrymalia,*[6] upon a papilla at the inner part of each lid. The tears enter these orifices and are conveyed along a bent canal into the lachrymal sac.

Tensor tarsi.—(Fig. 154.)—Arises from the os unguis,[4] and is inserted by two divisions[5] into the orifices of the lachrymal canal. Its nasal face adheres to the lachrymal sac. This is sometimes called Horner's muscle, though described by Duverney in 17.

Lachrymal sac and *nasal duct.*—Is a continuous tube contained in the passage formed by the nasal process of the superior maxillary, the

unguiform, and inferior turbinated bones. Its external coat is fibrous, and its internal mucous; it is larger above than it is below, and opens into the inferior meatus of the nose. The mucous lining forms a semicircular fold or valve.

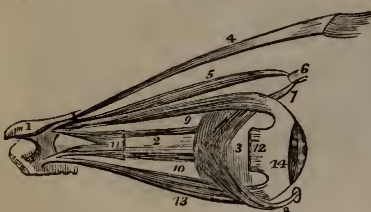
Fig. 154.



The muscles: *Levator palpebræ superioris.*[4] — *Origin*, near the optic foramen. *Insertion*, by a broad aponeurosis into the upper lid. It draws the lid upwards.

The *four straight muscles*, arise around the optic foramen; and are inserted, by tendinous expansions, within a few lines of the cornea. They are called superior,[9] inferior,[13] internal,[10] and external.[11]

Fig. 155.



The *superior oblique muscle*,[5] arises from the edge of the optic foramen, and plays over a tendinous pulley[6] upon the orbitary ridge of the frontal bone; is inserted into the sclerotica beneath, and beyond the superior rectus.

The *inferior oblique*,[8] arises from the nasal process of the superior maxillary bone; and passing below the inferior rectus, is inserted beyond it, into the sclerotica.

THE EAR.

The organ of hearing is composed of three parts: the External Ear, the Middle Ear or Tympanum, and the Internal Ear or Labyrinth.

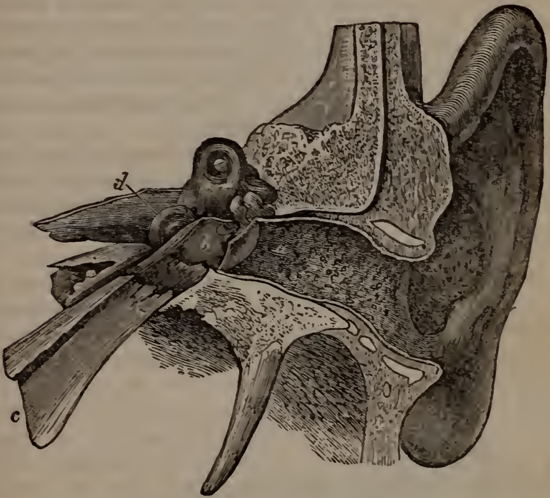
The *external ear* consists of two parts, the *pinna*, which is moveable upon the side of the head, and the *meatus*, a tube leading from it.

The *pinna* has a number of ridges and hollows upon its surface; these are: a prominent rim or *helix;* and within it another curved prominence, the *antihelix*, which bifurcates above, so as to enclose a space, called the *scaphoid fossa*, and surrounds a deep, capacious, central cup, the *concha*. The space between the helix and antihelix is the *fossa innominata*. At the end of the helix, in front of the concha, is a small detached eminence, the *tragus*, so named from its bearing a tuft of hair, resembling a goat's beard. Opposite this, behind and below the concha, is the *antitragus*. Below is the pendulous *lobe*, composed of dense areolar and adipose tissues. The *concha* is imperfectly divided into an upper and lower part, by the anterior curved extremity of the helix.

The *skin* of the pinna is thin, and contains an abundance of sebaceous follicles.

The *fibro-cartilage* is an oval, elastic plate, of a yellowish colour, in which are several fissures filled up with fibrous tissue. It is attached by an *anterior ligament* which is triangular, broad, and strong, to the zygomatic process, and by the *posterior ligament* to the mastoid process.

Fig. 156.



The muscles which move the pinna as a whole are the *attollens auriculæ,* arising from the aponeurosis of the occipito-frontalis, and inserted into the outer side of the cartilage of the ear opposite the scaphoid fossa; the *attrahens auriculæ,* arising also from the same aponeurosis in front of the zygoma, and inserted into the forepart of the helix; and the *retrahens auriculæ,* arising from the mastoid process of the temporal bone, and inserted into the back part of the concha. There are also some small muscles upon the pinna itself. The *major helicis* is narrow, about half an inch long, thin, and situated at the arched superior and anterior part of the helix; its fibres are vertical. The *minor helicis* is very small, and situated at the inferior and posterior arch of the helix. The *tragicus* is three-cornered, tolerably thick, with vertical fibres upon the tragus. The *antitragicus* is narrow and short, and passes from the antitragicus to the antihelix. The *transversus auriculæ* is on the posterior surface of the ear, extending from the convexity of the concha to the external part of the antihelix. The *dilatator conchæ* extends from the meatus auditorius to the anterior part of the tragus, which it draws forwards, and

thus dilates the concha. The *obliquus auriculæ* is upon the internal surface of the ear, between the elevations of the fossa innominata and the concha.

The *meatus*[a] (Fig. 156) is a cartilaginous and bony canal, about one inch long, narrow in the middle, and curved downwards; the skin lining it is covered with hairs, and glands secreting wax.

Membrana tympani.—The drum of the ear is a thin, semi-transpa rent, oval membrane, separating the cavity of the tympanum from the external ear. Its internal surface is slightly convex, and attached to the handle of the malleus. It is directed obliquely downwards and inwards, and it consists of three laminæ, the middle of which is strong and fibrous, and attached to the rim of the bone. The external surface is a continuation of the cuticle, and the internal is continuous with the mucous membrane, lining the cavity.

The *middle ear* or *tympanum*[b] is a small, irregular, bony cavity, in the petrous portion of the temporal bone, and bounded in front by the membrana tympani. It is filled with air, which enters by the Eustachian tube;[c] and contains a chain of small bones, and openings into the mastoid cells. (Fig. 157.)

The internal wall of the tympanum has two orifices of communication with the internal ear in the dried bone; the *fenestra ovalis*[a] (Fig. 157), an opening leading to the vestibule, and the *fenestra rotunda*,[b] opening into the cochlea; both of these are closed by membrane,

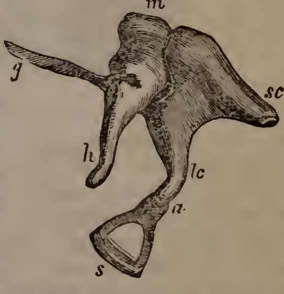
Fig. 157.

which prevents the escape of fluid contained in these inner chambers, and communicates vibrations to it. The fenestra ovalis is also closed by the foot-piece of the stapes. Between the fenestra is the promon-

tory,[c] an elevation corresponding to the first turn of the cochlea, and furrowed with two or three grooves[n] for the nerves which form the anastomosis of Jacobson. The *pyramid*[d] is a small conical projection behind the fenestris ovalis, presenting a small orifice at its summit, through which emerges the tendon of the stapedius muscle, which is contained within. At the base of the pyramid is an aperture through which the chorda tympani[m] enters the tympanum; thence this nerve passes forward between the handle of the malleus and the long arm of the incus, and emerges through the Glaserian fissure. Above the pyramid an arched prominence[e] indicates the course of the aqueduct of Fallopius, close to the tympanum, and behind this is the free communication with the mastoid cells.[f] At the upper part of the tympanum is the cochleariform process,[g] which bounds the canal[i] of the tensor tympani muscle. Below this is the commencement of the *Eustachian tube*, which is a straight canal, about two inches long, at first bony, then cartilaginous, and opening by a trumpet-shaped orifice into the pharynx, behind the inferior turbinated bone.

The *Bones* of the tympanum are four in number (Fig. 158); the *malleus*, or hammer, has a *head*,[m] separated by a *neck*, from a *handle*,[h] which is imbedded in the drum of the ear. A slight projection from the neck, receives the insertion of the tensor tympani muscle. The *processus gracilis* is long and thin, and extends from the neck forwards and outwards to enter the Glaserian fissure; to it is attached the laxator tympani muscle. A short conical process projecting from the back of the head, articulates with the incus.

Fig. 158.



The *Incus*, or anvil, resembles a molar tooth. Its body articulates with the malleus. Its *short crus*[s c] is directed backwards, and projects towards the mastoid cells. Its *long crus*[l c] has a hooked apex, which is bent inwards, and in contact with a small lenticular bone, called *orbiculare*,[a] which is often fused into the incus.

The *stapes* or stirrup has its base or foot-piece[s] fitting the fenestra ovalis; one of its sides is more curved than the other, and its head is in contact with the orbiculare.

The *muscles* moving these bones are the *tensor tympani*, arising from the spinous process of the sphenoid bone, and from the Eustachian tube, and passes through that canal above the bony portion of the Eustachian tube, to be inserted into the upper part of the handle of the malleus, which it draws inward, and thus stretches the membrane of the tympanum. The *laxator tympani* arises from the spinous process of the sphenoid bone, and passes through the Glaserian fissure, to be inserted into the processus gracilis of the malleus. There is some-

times another and lesser laxator tympani. The *stapedius* arises from the interior of the pyramid, and its tendon escapes from its summit, to be inserted into the head of the stapes.

Fig. 159.

The *Internal ear*, or *labyrinth*, consists of a bony and membranous portion; the bony labyrinth consists of three parts, the *vestibule* (V), the *semicircular canals* (S), and the *cochlea* (C).

The *vestibule* is a small, three-cornered cavity, behind the internal wall of the tympanum; into it open the semicircular canals,[s] by five orifices behind, and the cochlea, by a single one in front. On its outer wall is the fenestra ovalis,[o] and on its inner, several minute holes, including the macula cribrosa, for the entrance of a portion of the auditory nerve. The *aqueduct* of the vestibule[av] also penetrates it, from the posterior surface of the petrous bone. It also contains two depressions, called *fossa hemispherica* and *fossa semi-elliptica.*

The *semi-circular canals*[s, i, p] are three curved cylinders of half a line in diameter, whose extremities open into the vestibule by five orifices, each extremity being expanded like a flask, and called *ampulla.*[a] Two of these canals are vertical, and one is horizontal. The *cochlea* resembles a snail-shell, and consists of a conical canal, which makes two turns and a half spirally around an axis called the *modiolus,* which is a porous mass of bone, whose base is perforated by the filaments of the cochlear nerve. The *tube* of the cochlea is divided into two passages by the *lamina spiralis*, which terminates at the apex with a hook, called *hamulus;* which is covered by the *cupola.* The upper passage of the canal is called *scala vestibuli,*[sv] and the lower is the *scala*

tympani.[st] These passages communicate by an opening at the apex called *helicotrema.* The scala vestibuli opens into the vestibule, and the scala tympani opens through the fenestra rotunda into the tympanum, in the dried bone. The *aqueduct* of the cochlea opens by one extremity into the scala tympani, and by the other upon the inferior surface of the petrous portion of the temporal bone.

THE MEMBRANOUS LABYRINTH has the same shape as the bony cavities which it lines, and consists of a delicate membrane composed of several layers, containing the limpid fluid of Cotunnius, and the two small calcareous masses called *otoconites.*

The *endolymph* is the fluid contained within the membranous labyrinth; the *perilymph* is the fluid contained between the bony and membranous labyrinths.

THE AUDITORY NERVE, or *portio mollis* of the 7th pair, enters the meatus auditorius internus and divides into a vestibular and cochlear branch, which are expanded upon the membranous labyrinth and the walls of the cochlea

HAND-BOOK

OF

PHYSIOLOGY:

WITH

FIFTY-FIVE ILLUSTRATIONS.

(201)

CONTENTS.

PHYSIOLOGY.

PHYSIOLOGY is that science which treats of the actions or functions peculiar to living *organized* beings during the continuance of *health*, or *normal* life.

These actions, when they occur in a disturbed or irregular manner, constitute *disease*, or *abnormal life;* and become the subject of the science of Pathology. Every living being is *organized*, — that is, composed of different parts or *organs*, each of which has its definite structure, by which it differs from other parts, and is capable of fulfilling a certain end. The complex matter, which enters into the composition of an organized being, or *organism*, is called organic matter, and is obtained by its proximate analysis. By its ultimate analysis, this matter is resolved into its elementary principles, or inorganic elements, such as constitute other objects in nature.

The mineral kingdom does not exhibit the same distinctness and variety of structure, in the component parts of its various bodies, nor is there any adaptation of these parts to separate functions; they are, therefore, called *unorganized* or *inorganic*, and are, by chemical analysis, resolved into those simple elements which admit of no farther subdivision.

Organized bodies are found in one of two states or conditions, viz., that of *life*, or *death*. That of life, is a state of action, or of capacity for action. That of death, is one in which all vital action has ceased, and to which the disintegration of the organized body succeeds as a natural consequence.

An organized body in a state of *active* life, exhibits certain processes by which its growth and nutrition are provided for, and which enable it to resist the destructive influence of surrounding agents. The object of these processes, is to promote the development, and to preserve the integrity of the body itself. The simplest animal or vegetable, is an illustration of this remark.

The very processes which denote vital activity, may be sometimes temporarily suspended, even in fully-formed animals and vegetables; and in such instances, life may be said to become *dormant*. Of this we have an example in the ordinary wheel-animalcule, which, although

apparently killed by the drying up of the fluid in which it had been immersed, will speedily renew its active movements on being again supplied with water.

Organized bodies are capable of being resolved, by chemical analysis, into the inorganic simple elements; but the list of substances obtained from this source, is small in comparison with those found in the inorganic world, being only about eighteen. Of these, four alone, are considered *essential*, viz., carbon, oxygen, hydrogen, and nitrogen. Two, at least, of these will be found in every organic compound. The other simple substances are found in smaller quantities, and are less extensively diffused; these may be called its *incidental* or *non-essential* elements. These are, sulphur, phosphorus, chlorine, sodium, calcium, potassium, magnesium, silicon, aluminum, iron, manganese, fluorine, iodine, and bromine; the last two are obtained almost exclusively from marine plants and animals.

INCIDENTAL ELEMENTS.

Chlorine.—Chlorine does not exist free in organic nature, but only in combination with metallic bases, or with hydrogen. The chloride of sodium, or common salt, is a constituent of the animal fluids, and in certain classes of animals must be regarded as essential to life, because it is the source of muriatic or hydrochloric acid, the presence of which is one of the conditions of their digestion.

Iodine. — Iodine exists in sponges; and has been detected in the oyster and other marine molluscs.

Bromine. — Has been found in marine plants, and in the ashes of at least one animal, the janthina violacea, one of the testaceous molluscs.

Fluorine. — Fluorine exists, combined with lime, in the bones and teeth of animals. It has been found also in the vegetable kingdom to a sufficient extent to account for its existence in the animal kingdom.

Sulphur.—The sulphates are among the salts met with in the analysis of vegetable tissues; and sulphur is particularly found in some orders of plants, as the cruciferous family and the lichens. In the cruciferous plants—such as the coleworts—the presence of sulphur is indicated by the smell of sulphuretted hydrogen, given off during their decomposition.

Phosphorus.—Phosphorus hardly exists free in any part of nature. The salts which its acid combinations with oxygen form, are widely spread through the three kingdoms of nature, and appear to have important offices assigned to them in the economy of organic life.

In the animal kingdom phosphates make a prominent figure among its saline constituents. It has even been believed of late that uncombined phosphorus exists in the animal body, as in albumen and fibrine.

If the phosphates in the human body amount to about one-fifth part of its weight, as indicated by some calculations, then every human

body must contain several pounds of phosphorus. The phosphates, and particularly the phosphate of lime, are the chief hard materials of the bones in vertebrated animals, the carbonate of lime being in very inferior proportion. In the true shells, as in those of the crustaceous molluscs, or testaceous animals, there appear to be no phosphates, the hard substance being almost entirely carbonate of lime; but in the true crustaceous animals; as in the shells of the lobster, crab, and crayfish, there is both phosphate of lime and carbonate of lime, the latter predominating. In egg-shells there is a portion of phosphate of lime, while the predominating constituent is the carbonate of lime. The bone, as it is termed, of the cuttle-fish, contains no phosphate of lime. In the zoophytes the composition of the indurated part varies in different animals. Madrepore consists entirely of carbonate of lime, without phosphate; and the red coral yields a little phosphate of lime. In the higher animals phosphates are found generally throughout the fluids and soft parts, as well as in the skeleton.

Silicon, or *Silicium.* — Silica, or silicic acid, is found in small proportion throughout the organized kingdoms of nature. In the animal kingdom it is met with, in trifling quantity, chiefly in the bones and in the urine. In the vegetable kingdom it performs the important office of imparting strength to the stem, as in grasses, so as to enable them to support the weight of the grain. In the stem of the equisetacea, or horse-tails, the silica is seen to be disposed in a crystalline arrangement. In the bamboos of the East Indies there occurs a deposit of pure silica in considerable masses, to which the name "Tabashen" is given, and to which various mystical properties are ascribed.

Potassium. — The ashes of trees and of herbaceous plants growing elsewhere than on the sea-shore, contain the carbonate of potassa; and such is the sufficient proof of the existence of potassium generally throughout the vegetable kingdom.

In the animal kingdom potassium is not found so extensively diffused. Salts of potassa exist in some of the fluids of the human body, as in the blood, the milk, the urine. The same salts are abundant in the urine of herbivorous animals; that is, the excess of potassa received with vegetable food is thrown off by the urine.

Sodium. — Soda is more particularly the alkali of the animal kingdom. Besides the chloride of sodium, widely diffused, as already mentioned, in the animal kingdom, the sulphate of soda, phosphate of soda, and various combinations of soda with the organic acids, are met with, particularly in the animal fluids.

Calcium.—Lime, or the oxide of calcium, exists widely spread in organized nature. In the vegetable kingdom the salts of lime everywhere exist in minute proportion, while in the animal kingdom these salts accumulate so as to obtain a particular prominence, as has been already indicated under the head of phosphorus.

Magnesium. — Magnesia, or the oxide of magnesium, exists much

more sparingly than lime in organic nature. Phosphate of magnesia is a salt of continual recurrence in the chemical analysis of the parts of vegetables. Thus, in the ashes of wheat, rye, beans, and pease, the phosphate of magnesia exists to a considerable extent. It also occurs in the human blood, and in the bones.

Iron. — Iron appears to possess important offices in organic nature. Its oxide exists, combined with phosphoric acid, in such seeds as wheat, rye, and pease; and the oxide is discoverable in the ashes of various kinds of wood, — for example, in the ashes of fir-wood, the oxide has been found to the extent of 22·3 per cent. In the animal kingdom iron is a universal constituent of the blood.

Manganese.—Manganese is found in the analysis of various woods, and also in the human hair.

Between these elementary substances and the *organized* animals, or vegetable structure, there exists a class of compounds, called *proximate principles*, or *organic compounds*, or *organizable substances.* These are obtained in the first stage of chemical analysis of the various animal and vegetable tissues, and may be resolved by further analysis into their simple elements. For example, by the first analysis of *muscle*, we obtain the *proximate principle*, called *fibrine*, which is its chief constituent; subsequently, by the analysis of *fibrine*, we obtain the simple elements, oxygen, hydrogen, carbon, nitrogen, and sulphur, in certain proportions. So, on the other hand, by synthesis, the inorganic elements will produce the organic compound fibrine; from which again, the organic *structure*, muscle, is obtained. This, however, has never been effected in the laboratory, but solely in the living body. As the proximate elements are made up of ultimate elements, so the solid texture and fluids of organic bodies are composed by the union of the proximate elements. By the union of textures, organs are formed; by the union of organs, the body itself is framed.

The true proximate principles are those substances which are first obtained by the analysis of the organized textures; such are, gluten, starch, and lignine, from the vegetable; and albumen, caseine, or fibrine, from the animal textures. From these again are derived a great variety of products by various processes, owing to the tendency which their elements have to form new combinations. For example: by boiling starch in dilute acids, it becomes converted into a kind of gum, and starch-sugar. A large class of organic compounds is thus formed, which it seems proper to distinguish from the true proximate principles, under the name of *secondary organic compounds.*

In analyzing both the primary and secondary organic elements, they are found, in the majority of cases, to be composed of three or four essential elements; although in the secondary organic products of the vegetable class, we meet a few instances of binary compounds of simple elements.

When an organic substance, which is so constructed as to form part

of a living organism, is examined, it is found to possess some very distinctive characters. It contains water in considerable proportion; its form is more or less rounded, and free from angularity, and it is never crystallized. When it is necessary that it should possess considerable hardness, the amount of water is small, and an inorganic material is combined with the organic matter, as the phosphate of lime with gelatine in bones, or the silex with the epidermic tissues, in plants.

An organized body is composed of parts which differ from each other in structure and function; it may be subdivided into a series of textures, each differing from the others in physical and vital properties. When a great variety of textures exist in an animal, it is an indication of a high degree of organization.

The simplest and most elementary organic form, is that of a cell containing another within it (*nucleus*), which again contains a granular body (*nucleolus*). (Fig. 160.) This appears to be the primary form which organic matter takes as it passes from a condition of a proximate principle to that of an organized structure.

Fig. 160.

In some animals and vegetables, the whole body is composed of cells of this kind, and in the development of the embryo, all the tissues, however dissimilar, are composed of cells which are afterwards metamorphosed into the various structures that make up the perfect being.

Every organized body has a definite form and size; it has also its origin from parents, and has an allotted time to live; and after death it passes by decomposition into the simpler combinations of the inorganic elements.

Organized bodies grow by materials which are deposited within, and carried to the different parts of the structure by a vital process. They have also the power of repairing parts lost either by injury or disease. Parts that have been removed, may be replaced by a process of growth in the plant or animal, and this process is the more energetic in proportion as the structure of the organized body is more simple. The part that has been separated, however, in the higher orders, perishes; but in the lower orders, it often happens that the severed portion becomes a new and independent being, as is the case with the hydra, in the animal kingdom, and with certain members of the vegetable kingdom, cuttings of which will often produce a similar plant to that from which it was taken.

Organized bodies have the power of appropriating or assimilating to their own textures, other substances, both organic and inorganic. By virtue of this process, plants and animals are continually adding to themselves new materials by which they are nourished. Plants derive their nourishment from the inorganic world, from the excretions

of animals, and from decaying organic matter. Animals, on the other hand, can be nourished only by organic matter, either animal or vegetable. Both possess the power of re-arranging the constituents of these substances into forms identical with those of the elements of their various tissues.

But whilst new matter is being deposited, the old particles must be thrown off, otherwise the growth would be unlimited; and if excretion alone went on, disorganization would very soon occur. In both operations, new combinations are continually taking place, as it were, in opposite directions; in the one, from the simple to the complex organized parts; in the other, from the complex constituents of the textures to the simple organic or inorganic compounds.

From the *decomposition* of animal and vegetable matters, a great variety of products results. This decomposition is of two kinds, distinguished by the names of *fermentation* and *putrefaction;* the former term has been limited by Liebig to the decomposition of substances devoid of nitrogen, and the latter to that of azotized substances. The products of this decomposition are nitrogen and hydrogen (which partly escape in a free state), water, carbonic acid, carburetted hydrogen, olefiant gas, ammonia, cyanogen, prussic acid, phosphuretted hydrogen, and hydrosulphuric acid; while in some cases the elements reunite in different proportions, so as to form a new organic compound, as in the production of sugar from starch in the saccharine fermentation. Sometimes from one organic substance two new compounds are generated, one organic, the other inorganic; as in vinous fermentation, during which carbonic acid and alcohol are formed from sugar.

The conditions more or less necessary for the spontaneous decomposition of organic matter, are moisture, the access of atmospheric air, and a certain temperature. The first and last are always necessary, the second not invariably.

The gaseous products of the decomposition of animal matter, and of the human body in particular, are carbonic acid, sometimes nitrogen, hydrogen, sulphuretted hydrogen, phosphuretted hydrogen, and ammonia. Acetic acid is also formed, and sometimes nitric acid.

By contrasting the characters of organized bodies as described, with those of the inorganic world, the distinction between the two may be seen. Inorganic bodies are either aeriform, liquid, or solid; they are irregular in shape, and generally angular. No distinction of parts or organs is to be found in the mineral substance; its minutest fragment is in every respect of the same nature as the largest mass. Inorganic bodies are unlimited in size and duration, continuing for ages without augmentation or waste, provided no mechanical or chemical agent be brought to act upon them. There is in them no growth from internal deposition; they increase, if at all, by particles deposited without; there is no power of reproducing themselves, or repairing lost parts, no excretion, no assimilation. The constant round of actions witnessed in the living organized structure, and which is called *life,* in

them is wanting. The affinities of their component elements being satisfied, all remains at rest. Change is the exception; rest the law. Whilst in organized bodies, *rest* is the exception, *change* the law.

DISTINCTIONS BETWEEN ANIMALS AND VEGETABLES.

Under the head of *organized bodies* are included both animals and vegetables; and it is therefore desirable to point out some of the characteristic differences between these two kingdoms. Development, growth, excitability, propagation, and decay are the general phenomena and properties of all organized bodies, and are the results of organization; but there are other properties peculiar to animals, which may therefore be termed *animal,* in contra-distinction to the general *organic* properties; these are *sensation* and *voluntary motion.* Plants, it is true, are not entirely destitute of motion; their organization is attended with internal motions, such as the circulation of the sap; moreover, they turn spontaneously to the light; their roots seek the most nutritious soil, and some even perform evident movements which seem to be spontaneous, as if they indicated sensibility. Such movements are seen in the sensitive plant and in the Venus' fly-trap. These, however, are strictly *organic,* and result from physical changes produced directly in the part impressed. Plants are *irritable* but not *sensible.* Irritability must not be confounded with sensibility. Plants cannot be said to possess sensibility unless they manifest consciousness.

The presence of a *stomach* is another characteristic of animals. This may be a mere result, however, of the nature of their food. Vegetables obtaining their food in a liquid or gaseous form, do not require a cavity for its reception. The only instance in which such an organ may be supposed to exist is in the case of the pitcher-plant, in which the leaves are so arranged as to form cavities for the retention and solution of the bodies of insects; the dissolved food is then absorbed into the plant.

Animals, on the contrary, cannot live on inorganic materials; they can only employ them as food after they have been united into certain peculiar organic compounds. Now, as they cannot incorporate any alimentary substances into their own tissues until they have been reduced into a fluid form, they require a cavity, the stomach, to effect this reduction.

Another difference is observed in the manner in which the first development of the germ takes place. The first nisus of animal development is towards the formation of a stomach, for the internal reception and digestion of food; whilst the first processes of vegetable evolution tend to the production of a leaf-like membrane, which, like the permanent *frond* of the lower classes of plants, absorbs nourishment by its expanded surface only. The seed of the plant and the egg of the animal consist principally of a store of nourishment prepared by the parent for the supply of the germ, which is introduced into the midst

of it. In both instances, the first development of the germ is into a membranous expansion, which absorbs the alimentary materials with which it is in contact, and prepares it for the nourishment of the embryonic structure. In plants, this membranous expansion absorbs by its *outer* surface only, which is applied to the albumen of the seed. In animals, the expansion is developed in such a manner, that it surrounds the albumen, inclosing it in a sac, of which the inner surface only is concerned in absorption, and becomes the temporary stomach of the embryonic structure.

The *circulation* is much more simple in plants than in animals, and is, in them, never provided with a special organ for the distribution of the sap; they have no heart.

The function of *respiration* has usually been enumerated among the distinctive characteristics of animals and plants, it being supposed that oxygen is absorbed and carbonic acid evolved by the former, and a converse change effected in the surrounding air by the latter. This, however, is not correct, the products and process of respiration being the same in both; whilst the absorption of carbonic acid and elimination of oxygen which take place only in day-light, is much more analogous to the *digestion* of animals. Lastly, plants having only one mode of manifesting life, namely, by vegetation, do not require manifold organs in addition to their roots, stem, and leaves, and, with the exception of the organs of fructification, present merely a repetition of perfectly similar parts, in all of which the simple relation of branches to leaves is the same, and even the sexual organs are evidently allied to the leaves, and in some cases are transformed into them. In animals, on the contrary, the reciprocal action of circulation, respiration, and the nervous system is actually necessary to life. The respiratory movements are dependent on nervous influence; but the nerves do not exert this influence unless supplied with blood which has been aerated in the lungs; and the blood again is not sent to the different organs, and therefore not to the nerves, unless the contractions of the heart are performed; while the heart in its turn is dependent on the influence of arterial blood and the nerves. The brain, heart, and lungs, therefore, may be likened to the main wheels of the animal machine, each acting on the other, and all set in motion by the change of material which takes place in respiration.

ELEMENTARY PARTS OF ANIMAL STRUCTURE.

The animal body is composed of *fluids* and *solids.* The former constitute the blood, chyle, lymph, and the secretions of the various glands; the latter, the various textures and viscera. The proportion of fluids far exceeds that of solids, though it is a difficult matter to form a positive estimate. Richerand says they are in the proportion of six to one; Chaussier of nine to one. The latter found that a dead body which weighed one hundred and twenty pounds, after desiccation

in an oven weighed only twelve. Blumenbach possessed the entire *perfectly dry* mummy of a Guanche, which with all the muscles and viscera, weighed only seven pounds and a half.

Water is one of the most important of the constituents of the human body; it enters largely into the composition of all the fluids, and gives flexibility and softness to the various solid textures. It is also a solvent of many organic matters, and either in solution, or suspension, serves to carry them to the various textures and organs. As a general rule, the amount of water contained in an organized structure bears a proportion to its vital activity, though, of course, there are exceptions to this rule.

It has been already shown that there exists between the inorganic elements and the organized animal or vegetable structure a class of compounds called *proximate principles*, and that from these a great variety of products could be obtained, owing to the tendency which their elements have to form new combinations, and that these latter were called *secondary organic compounds*. The following table exhibits these two classes of substances.

PROXIMATE PRINCIPLES.		SECONDARY ORGANIC COMPOUNDS.	
Albumen.	Compounds of proteine.	Urea.	In the urine.
Fibrine.		Uric or lithic acid.	
Caseine.		Cholestearine; in the bile.	
Gelatine.		Biliary matters.	
Chondrine.		Pepsine: in the gastric juice.	
Oleine.		Sugar of milk.	
Stearine.		Lactic acid.	
Margarine.		(Kreatine.	
Hæmatosine.		Kreatinine.)	
Globuline.			(*Todd and Bowman.*)

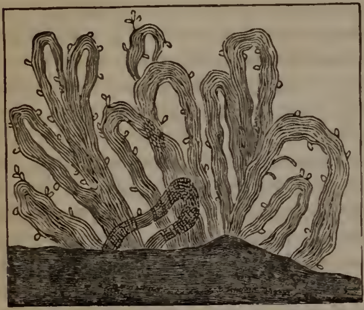
Albumen.—Exists in two forms, *fluid* and *concrete*. In the latter form, when pure, it is perfectly white; hence its name (albus, white); it is found *solid* in the brain, spinal cord, and nerves, and in the mucous membranes, which are thence called albuminous tissues. It is *fluid* in the serum of the blood, the lymph and chyle, and in many of the secretions. It is coagulable by heat, acids, and corrosive sublimate, but not *spontaneously*.

Fibrine is found in solution in the chyle, lymph, and blood. It is the basis of the muscles, in which it is found in a solid form. It is one of the most abundant of the animal substances. It may be obtained by stirring blood as it is flowing, or by washing a clot in clean water so as to dissolve out the colouring matter.

Fibrine is white, solid, flexible, and slightly elastic; insoluble in water, alcohol, and acids, but soluble in caustic potassa. Chemically speaking, fibrine does not differ essentially from albumen. Physiologically, the great variation lies in the *spontaneous* coagulation of the fibrine, and when coagulated it is found to possess a definite *fibrous* arrangement, the fibres crossing each other in every direction.

Fibrine is by some regarded as the plastic element of the blood, and with the serum constitutes the liq. sanguinis; it forms the buffy coat of the blood, and is found in those exudations which take place either in inflammation, or from a peculiar formative action, destined to repair an old tissue, or produce a new one; under these circumstances, it is often called *coagulable lymph.* (Fig. 161.) This is the commonly-received opinion. In Simon's recent work on General Pathology the following views in opposition to it are strongly supported. The analyses speak for themselves, and if true are destined to give to this organic element a lower position in the scale than it has hitherto occupied. This, however, is not the place to discuss the question.[1]

Fig. 161.



"Fibrine is undiminished by bleeding, however frequently repeated; nay, it often, or even usually, increases under this debilitating treatment: its highest figure given in Andral's book (10·2) was at a fourth bleeding; and Scherer found it as high as 12·7 at the third venesection in a case of pneumonia. I find that under many other circumstances of exhaustion and weakness and inanition, during the progress of starvation,[2] during diseases essentially anæmic, during violent fatigue, and the like, its proportion has been found at least as high, perhaps higher, than in the inflammatory process. And as in these respects I find its proceeding to be in direct contrast to that of the red globules (which we know to be potential elements in the blood, and which are at once reduced by bleeding and starvation), so also do I find a similar contrast in another striking particular. Messrs. Andral and Gavarret, in the course of their extensive researches in the comparative physiology of the blood, ascertained that an improvement in the breed of an animal tended always (*cæteris paribus*) to increase the proportion of its coloured blood-corpuscles; they found that the same improvement tended likewise to diminish the proportion of

[1] For a full discussion of this subject, the reader is referred to Carpenter's Principles of Human Physiology, edited by F. G. Smith, M.D., p. 217, *note.* Edition of 1855.

[2] "In analysing the blood of seventeen healthy horses, Andral and Gavarret found the maximum of fibrine to be 5 per 1000; the minimum to be 3; the mean to be 4. In dealing with diseased horses, many of them meagre and half-starved, Dr. Franz Simon found this proportion increased to 11 or 12 per 1000. In one case, particularly, of experimental starvation of a horse, after four days' total abstinence, this observer found that the animal's proportion of fibrine had risen from 5 to 9."

its fibrine. And I find further indications of the same inverse ratio between the fibrinousness and the perfection of the blood, in the facts — that there is little or no fibrine in the blood of the fœtus, none in the egg, none in the chyme, and less in the blood of the carnivora (who feed on it) than in that of the herbivora.

"Some of these facts, derived from very different sources, appear quite inexplicable on the theory that fibrine is essential to the progressiv development of the tissues; and the opposite inference seems unavoid able, that it must be considered an excrementitious product, derived from the waste of the tissues or the oxidation of the blood, and in progress of elimination from the system. This conclusion carried into the domain of pathology, would lead us to suppose, that an augmented proportion of fibrine in the blood (whether occurring in active disease, or within the limits of apparent health) can be taken as an indication only of increased labour and waste in certain elements of the body, not of an increased development in the resources and nutrition of the blood. And on the same ground it would appear that a super-fibrination of the blood, in acute inflammatory diseases, must be regarded as a consequence and effect of those diseases, not as their cause, and not as a primary affection."

Caustic potassa, carb. potass., chloride of sodium, and many neutral salts, when mixed with blood, will prevent the coagulation of fibrine.

Caseine has many properties in common with albumen and fibrine. It exists in greatest abundance in milk, and is the basis of cheese. Its occurrence in other fluids has not been positively detected. It may be obtained by allowing milk to remain at rest till it is coagulated, skimming off the cream, then washing and drying the clot.

Caseine is very perfectly coagulated by the action of *rennet*. This coagulating power is not due to the acid of the stomach, but to the pepsine resident in it. It is not coagulable by heat, but is readily precipitated by the addition of an acid. It contains sulphur, but no phosphorus.

Proteine.—If albumen, fibrine, or caseine, be dissolved in caustic potassa, and acetic acid be added to the solution, a precipitate takes place of a translucent, gelatinous material. This substance was called *proteine* by Mulder, the discoverer, because it was supposed to be the starting-point or basis of all the tissues (from πρωτευω, I take the first place). Liebig, however, and Fleitmann, deny the existence of any such substance as proteine, on the ground that what Mulder so called and considered to be formed of none but the essential elements, always contains a certain quantity of sulphur, as the albumen or other substance from which it was prepared did. This question is yet undetermined; for since Liebig published his opinion, Mulder has repeated his own, and maintained that, though the proteine prepared as above described does contain sulphur, yet it is not in the form of elemental sulphur, but in that of hypo-sulphurous acid. He believes albumen, fibrine, and other principles of this group to be compounds of proteine with sulphamid and phosphamid, and that in dissolving them in pot-

ash-ley, these compounds are decomposed with water, ammonia being formed and given off, while sulphurous and phosphorous acids combine with the proteine. The question must, as yet, be thus left; but there seems sufficient probability in Mulder's views to justify the received use of the term *proteine-compounds*, in speaking of the class, including fibrine, albumen, and others to which the name of albuminous compounds used to be applied.

The precipitate is the same no matter which of the substances above named be taken, be it animal or vegetable. They are looked upon therefore as modifications of proteine by the addition of certain proportions of phosphorus or sulphur, or both.

Dried proteine is a hard, brownish-yellow substance, without taste, and insoluble in water and alcohol. It unites with oxygen in definite proportions, so as to form a *binoxide* and *tritoxide*. These are formed in the lungs from fibrine, which in a moist state possesses the property of absorbing oxygen. The tritoxide, especially, is formed every time that the blood passes through the lungs, and given out again when it returns to the system. A much larger quantity is formed also during the inflammatory condition, constituting the *buffy coat.*

Pepsine and *Pyine* are also included under the head of proteine-compounds by some authors, although the existence of this substance in them is denied by many others. The first is a peculiar substance thrown off from the mucous lining of the stomach, and has been called *gasterase*, from its analogy to *diastase;* the second is also a peculiar substance found in *pus.* Mulder regards it as a *protoxide of proteine.* Proteine undergoes decomposition very readily when acted on by other chemical substances, especially by alkalies. This is a property which must be continually acting in the living body; since the blood is known to have an alkaline reaction.

Gelatine is the chief constituent of the cellular, or areolar tissue, skin, tendons, ligaments, and cartilages: it is also contained in large quantities in bones. It is obtained by boiling any of the above substances, and allowing the solution to cool. Glue is an example of impure Gelatine. It contains *no proteine*, hence it has been concluded that it cannot yield albumen, fibrine, or caseine. It is insoluble in cold water, alcohol, and ether, and has a strong affinity for tannin. The process of tanning leather results from this affinity. Proteine cannot be obtained from gelatine, but it is probable that it or its compounds have yielded gelatine, for the gelatine of the chick must be produced from a compound of proteine.

Chondrine resembles gelatine in many respects, except that it is not precipitated by tannin, and yields a precipitate to acetic acid, alum, acetate of lead, and protosulphate of iron, which do not disturb solutions of gelatine. It is obtained by boiling the permanent and temporary cartilages, also from the cornea; and gelatinizes when cool.

Oleine, *stearine*, and *margarine* are proximate principles of fat The first gives fluidity, the second is the solid ingredient, and the

third is of medium consistency. Stearine is but sparingly present in human fat.

For sake of convenience, we still speak of the oily constituents of organic bodies as proximate elements, though, strictly speaking, the oily acids, of which these oils consist, are the true proximate elements. The term fixed oil, or fat, denotes a compound of oxide of glyceryle with certain organic acids, chiefly compounds of that oxide, with stearic, margaric, and oleic acids, — two of these, and often all three, being present. In animals, fat occurs chiefly in the cellular membrane, or in a tissue connected with it. Among plants, oils occur in the seeds, capsules, or pulp surrounding the seeds, and very seldom in the root.

Hæmatosine is the red colouring matter of the blood contained in a capsule which is composed of *globuline.* The latter is regarded by some chemists, as a proteine-compound.

Globuline.—In the blood-globules, besides hæmatosine, there is another albuminous principle, on which the name globuline has been bestowed.

Kreatine.—There has been obtained of late, from the juice of flesh, a remarkable substance, to which the name kreatine has been given. It is a crystalline compound, consisting of oxygen, hydrogen, carbon, and nitrogen. It has neither acid nor basic properties. It is very soluble in hot water, and cold water retains a minute portion of it in solution. By the action of strong acids it is resolved into a new body, named kreatinine. Kreatine has been found, in minute quantity, in the muscular flesh of the common domestic quadrupeds, and also in that of birds and fishes.

Urea.—The chief peculiar constituent of the urine is urea, which consists of oxygen, hydrogen, carbon, and nitrogen, the last being the predominant element. Although, then, the constituents of urea are the same as those of albumen, fibrine, and caseine, the proportions are very different. In those albuminous bodies the proportion of nitrogen is only about 15 per cent., while in urea it is 47 per cent. In those so-called forms of proteine the carbon amounts to 52 or 53 per cent.: while in urea it is no more than 20 per cent. In the former, the hydrogen is very much the same per cent. as in the latter; but the oxygen in urea is 27 per cent., while in the forms of proteine it is about 22 per cent.

Uric Acid.—In uric acid the proportion of nitrogen is also great, while that of carbon is also considerable. The nitrogen is present to the extent of 32 per cent., while the carbon amounts to 37 per cent. Uric acid is secreted, not only by animals and birds, but also by serpents and many insects. Guano consists chiefly of uric acid combined with ammonia.

Hippuric Acid.—In the urine of graminivorous animals another acid has been discovered, to which the name of hippuric has been given. In this acid there is no more than 8 per cent. of nitrogen.

In regard to the *secondary organic compounds*, they are transformed by some unknown chemical agency, from the elements of the tissues, to be excreted from the system by particular organs. There is reason also to believe, that, at least with respect to some of them, the elements of the food contribute immediately to their formation. Of this latter hypothesis the bile is supposed to be an example.

CLASSIFICATION OF THE TISSUES.

From the proximate principles described above, are developed the various tissues of the body. In combining to form the different structures, the solids are arranged in a variety of ways. Of these the chief are in filaments, or elementary fibres, tissues, organs, apparatus, and systems. By *filament* is meant the elementary solid. A *fibre* consists of a number of filaments united together. By the union of tissues, *organs* are formed. A number of different organs united to accomplish one end constitute an *apparatus*. When a number of organs of similar or analogous structure are united for one end, they form a *system*. Schwann advanced the doctrine that *all* the tissues of the body were formed from *cells*. It has been shown, however, by subsequent research, that this assertion was rather too hasty; that, although many tissues retain their original cellular type throughout life, and many more are formed from cells which are afterwards metamorphosed, there are some in which no other cell-agency is employed than that concerned in the elaboration of the plastic material. This is the case in certain forms of the very delicate structureless lamella known by the name of *basement membrane*, found beneath the epidermis and epithelium, in which no vestige of cell structure can be seen, but which appears rather to resemble that of which the cell walls are themselves constituted. At other times it seems to be composed of the coalesced nuclei of cells whose development has been arrested. In regard to the fibrous tissues, a doubt also exists as to whether they are developed by a metamorphosis of cells, or whether they are not, like basement membrane, produced by a consolidation of a plastic fluid which has been elaborated by cells.

The following arrangement of the human tissues, is that adopted by Dr. Carpenter, and expresses their fundamental relation to the elements above alluded to, viz.: *Membrane*, *Fibres*, and *Cells*.

a. Simple membranous tissues. — Of these there are scarcely any examples in the human body except in the capsule of the lens, and the posterior layer of the cornea. The walls of the primary organic cells are also composed of it; and it is employed in forming muscle, nerve, and the adipose and tegumentary tissues. Its principal character is extension, but its ultimate arrangement defies the highest powers of the microscope.

b. Simple fibrous tissues.—Under this head are included the white and yellow fibrous tissues and the areolar tissue. These are extensively used for connecting different parts, or for associating the ele-

ments of other tissues. The ligaments of joints are composed of the white or yellow fibrous tissues; and areolar tissue surrounds and connects the component parts of nerves, muscles, vessels, &c.

c. Simple cells floating separately and freely in the fluids, as corpuscles of the blood, lymph, and chyle.

d. Simple cells developed on the free surfaces of the body, as epidermis and epithelium.

e. Compound membrano-fibrous tissues, composed of a layer of simple membrane, developing cells on its free surface, and united on the other to a fibrous or areolar structure, as the skin, mucous membranes, serous and synovial membranes, lining membrane of blood-vessels, &c.

f. Simple, isolated cells, forming solid tissues by their aggregation, as fat cells, the vesicles of gray nervous matter, absorbent cells of the villi, the cellular parenchyma of the spleen; the cells being held together in all these cases by the blood-vessels and areolar tissue which pass in between them. In cartilage, and certain tissues allied to it in structure, the cells are united by intercellular substance, either homogeneous, or of a fibrous character.

g. Sclerous or hard tissues, in which the cells have been more or less consolidated by internal deposit, and more or less completely coalesced with each other, as the hair, nails, &c. These may be more properly ranked under the epidermic tissues, but the result is more characteristically seen in bones and teeth. The sclerous tissue contains a large proportion of inorganic material to which it owes its hardness. It differs from all the other tissues except cartilage and fibro-cartilage, which for hardness might be classed with it.

h. Simple tubular tissues, formed by the coalescence of the cavities of cells, without secondary internal deposit, as the capillary blood-vessels and smallest lacteals and lymphatics.

i. Compound tubular tissues, in which, subsequently to the coalescence of the original cells, a new deposit has taken place within their cavities. In the tubuli of the white nervous matter, and in those of the least perfect form of muscular fibre, the secondary deposit has only a granular or amorphous character; but in the striated muscular fibre it is composed of minute cells.

The limits of a work like this will not admit of an examination of all these different classifications. That one has been adopted which seems to be most generally received.

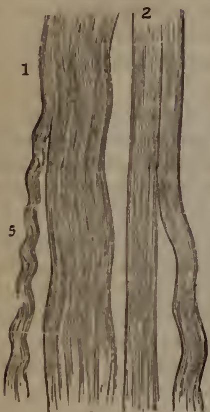
The elementary membrane was alluded to and described, as far as seemed requisite, in the commencement of this article; we proceed at once, therefore, to the consideration of the second group of tissues, —the *fibrous.*

OF THE SIMPLE FIBROUS TISSUES.

Under this head are included two kinds of texture, resembling each other only in the fact that they present to the eye a *fibrous* aspect.

They differ in their ultimate structure, colour and physical properties. They are both used in connexion with the skeleton, and are concerned in the mechanism of animal motion and locomotion. They are known as the *white* and *yellow fibrous tissues.*

Fig. 162.

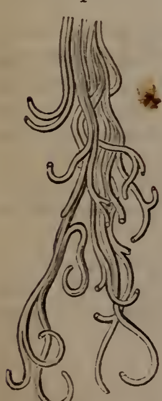


2. Straight appearance of the tissue when stretched. 1, 3, 4, 5. Various wavy appearances which the tissue exhibits when it is not stretched.

It will be remembered that there is reason to doubt whether they are generated by a metamorphosis of cells, or whether they are not produced by the consolidation of a plastic fluid which has been elaborated by cells; the latter is the more probable hypothesis.

The *white fibrous tissue* is found in textures requiring great flexibility, strength, and an unyielding firmness; such as ligaments, tendons, fibrous membranes, aponeuroses, &c. It presents itself in the form of inelastic bands, somewhat wavy in their direction, sometimes arranged side by side, at others disposed on different planes and interlacing and crossing in various directions. (Fig. 162.) It is *inelastic*, and under ordinary circumstances, *inextensible;* contains but few vessels, and no nerves, at least they have never been satisfactorily discovered. It seems entirely destitute of any vital properties; and its chemical nature is such that it needs very little interstitial change to maintain its normal composition. It yields gelatine in considerable quantity by boiling. When treated with acetic acid it immediately swells up and becomes transparent.

Fig. 163.



When a solution of continuity takes place in this tissue it is readily repaired by the interposition of a new substance, in every respect resembling the original, save that it wants the peculiar glistening aspect, and is more bulky.

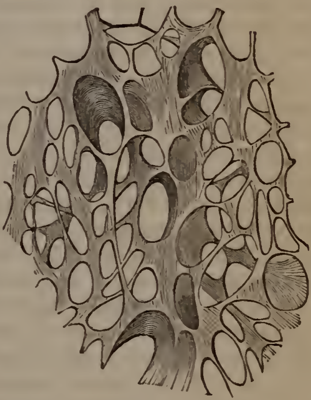
Yellow fibrous tissue, differs from the last in colour, and in the possession of *great elasticity.* It consists of bundles of fibres covered by a thin sheet of areolar tissue; the fibres are either round or flattened, brittle and disposed to curl at the end. (Fig. 163.) It is found in the middle coat of the arteries, in the chordæ vocales, the ligamentum nuchæ, the ligamenta subflava, in the crico-thyroid membrane, and in the longitudinal bands of the trachea and its branches. It undergoes little or no

change by boiling, and is unaffected by acetic acid; it resists putrefaction, and preserves its elasticity during a long period.

Both these varieties may be detected in the tissue now generally designated as *areolar*, formerly *cellular*. This is formed by the crossing and interlacing of minute fibres and bands interwoven in every direction, so as to leave innumerable interstices which communicate with each other; this may be proved by filling them with air or water, as occasionally happens in the living body in anasarca and traumatic emphysema. (Fig. 164.)

These interstices are not cavities possessed of definite limits, because they are open on all sides. The application of the term *cell* to them is, therefore, inappropriate. The term *cellular* is more applicable to those tissues which consist of a congeries of distinct cells.

Fig. 164.



The *areolar* tissue is one of the most extensively diffused of all the elements of organization, being found in every part of the fabric, except in the compact portion of bone, teeth and cartilage. It does not exist in the brain either, except around the minute vessels. Its great use is to connect together organs and parts of organs which require a certain degree of motion upon each other. To do this, it is placed in their interstices, and is more or less lax, and more or less abundant, according to the particular exigency of the part.

It has scarcely any *vital* properties, but possesses the physical properties of extensibility and elasticity. It has neither contractility nor sensibility, the nerves which it contains, being merely distributed in it in their route to other organs.

Areolar tissue is readily regenerated when destroyed, and yields gelatine very readily by boiling. The interstices are filled during life with a fluid resembling dilute serum, which soaks out of the blood-vessels by *transudation;* a morbid increase of this fluid occasions the condition called *anasarca*, which is recognised by the skin pitting under the pressure of the finger.

SIMPLE CELLS FLOATING IN THE ANIMAL FLUIDS.

Of these we have examples in the corpuscles of the *blood, chyle,* and *lymph.* The corpuscles of the blood consist of an investing capsule composed of *globuline*, and a contained fluid, secreted in the interior of the cell, of a red colour, called *hæmatosin* or *hæmatin.* In shape

they are somewhat disk-like, the sides are concave, and there is a bright spot in the centre, which by many has been regarded as a nucleus. The form of the disk is readily altered by reagents, the membrane of the cell-wall being readily permeable by liquids either inwards or outwards, as the relative density of the contents of the cell and the surrounding fluids may direct. The cell-walls are tough and elastic; so that, as they circulate, they admit of elongation and various changes of form in adaptation to the vessels, yet recover their natural shape as soon as they escape from compression.

It is supposed that these cells contain a nucleus, though it cannot be distinctly brought into view in the corpuscles of human blood, as it can in that of the oviparous vertebrata. Dr. G. O. Rees states that he could distinguish a nucleus on the ruptured cell-walls, although they escape observation when within the corpuscles in consequence of their high refractive power.

Their size varies in the same individual, and they bear no constant relation to the size of the animal. In man their average diameter is about 1-3200ths of an inch.

Chemical Composition.—*Globuline* is a proteine-compound, and does not differ essentially from other substances that result from the organization of the proteine-compounds. *Hæmatin*, when separated from albuminous matter, is of a dark brown hue, its formula is C 44, H 22, N 3, O 6, F 1. The red colour is not due to the presence of iron, since, as Scherer has shown, it may be entirely dissolved out without destroying the colour.

In regard to the *origin* of the red corpuscles there is considerable difference of opinion. Most physiologists look upon them as nucleated cells, having the power of reproducing themselves, either by splitting up the disk and nucleus into six or seven segments, or, as Dr. Rees has observed, by an hour-glass contraction of the corpuscles, by which two unequal-sized circular bodies were eventually produced from each.

In the formation of the embryo, they have an origin common to that of all the other tissues. In the embryo of the bird, they are formed in that portion of the germinal membrane known as the *vascular layer;* this consists of delicate cells very uniformly disposed, and whilst capillary vessels are formed by the union of the cavities of these cells, their walls being absorbed at the points of contact, the *blood-disks* seem to be developed from the granules or cell-germs they contain. These corpuscles are larger in the embryo than in the adult, which fact is an argument in favour of the independent circulation in the fœtus. When, in the development of the embryo, the lymph and chyle begin to be formed and added to the blood, their corpuscles are developed so as to supersede those produced in the manner just described.

According to Dr. Carpenter, the *uses* of the red corpuscles are now definitely settled. Since they are confined nearly entirely to the vertebrata, and are absent in the embryo of higher animals at an early

period of their development, the inference appears highly probable, that they are not essential to growth or nutrition. On the other hand, as they are found most abundant in those classes of vertebrata which possess the highest temperature, and are known to undergo important changes in the pulmonic and systemic capillaries,—it seems highly probable that their office is to convey oxygen into the system, and carbonic acid out of it; serving, in fact, as the medium for bringing the tissues into relation with the air, the influence of which is necessary for the maintenance of their vital activity.

A peculiar condition of the red corpuscles in inflammatory blood—a condition which appears to exist naturally in the blood of horses—is the principal cause of the formation of the buffy coat. It gives them a great tendency to adhere together in rolls or columns, like piles of coin, and then, very quickly, these rolls fasten together by their ends, and cluster; so that, when the blood is spread out thinly on a glass, they form a kind of irregular network, with crowds of corpuscles at the several points corresponding with the knots of the net. Hence, the clot formed in such a thin layer of blood looks mottled with blotches of pink upon a white ground: in a larger quantity of such blood, as soon as the corpuscles have clustered and collected in rolls (that is, generally in two or three minutes after the blood is drawn), they begin to sink very quickly; for in the aggregate they present less surface to the resistance of the liquor sanguinis than they would if sinking separately. Thus quickly sinking, they leave above them a layer of liquor sanguinis, and this coagulating forms a buffy coat, the volume of which is augmented by colourless corpuscles, which have no tendency to adhere to the red ones, and by their lightness float up clear of them.

Besides the cells which have been described as floating in the blood, viz., the red corpuscles, there are also found, both in this fluid and in the *chyle* and *lymph*, certain *colourless* corpuscles which are observed to be present in the blood, both of the vertebrata and invertebrata. The dimensions of these corpuscles are nearly constant throughout the different classes of vertebrata; their diameter being seldom more than 1–3000th of an inch. They have no distinct nucleus, but are studded with minute granules, which may occasionally be seen in active motion within them, and which are discharged when the corpuscles are treated with liq. potassæ. In the circulating blood, they are always found on the *outside* of the current, where the motion of the fluid is slow. They are looked upon as cells of a transitional character. They are not in themselves destined to form an integral part in any permanent structure, but, after attaining a certain maturity, are finally converted into red corpuscles of the blood.

OF CELLS DEVELOPED ON FREE SURFACES.

Of these we have examples in the cells composing the *epidermis* and *epithelium*, two structures which are essentially alike in their

origin, mode of development, situation, and individual history; they differ, however, in the purposes which they respectively serve in the economy.

The epidermis is the cellular covering of the external surface, the epithelium is the corresponding covering of the internal cavities. They both consist of cells, which are developed from the subjacent membrane, which are nourished by its vessels, and which are, after a time, cast off from its free surface, to be replaced by a succeeding generation.

The *epidermis* is not permeated by either vessels or nerves, but consists solely in a congeries of nucleated particles arranged in laminæ. Those that lie deepest and rest immediately on the cutis are small granules scattered in a homogeneous matrix. Those of the next layer are rounded cells of transparent membrane, in which similar granules can be seen. In the succeeding layers these cells are more and more compressed as they are nearer to the surface; and on the surface they are mere flattened scales.

The superficial scales are being constantly shed; and new ones are as constantly formed below from germs, which are supplied by the basement membrane. The soft layer immediately in contact with the true skin was formerly called *rete mucosum*, but it is now proved to consist of the same elements with the ordinary epidermis. The epidermis varies in thickness in different parts, according to the amount of pressure or friction to which it is subjected.

The *use* of the epidermis is to protect the true skin from mechanical injury, and from the irritating effects of exposure to atmospheric vicissitudes.

Mixed up with the epidermic cells, we find the *Pigment cells*, or those which contain the peculiar colouring matter of the races. The black colour is caused by the presence within them of a number of flat or oval granules, which are transparent, and exhibit an active movement when set free from the cell. The chemical nature of this pigment is unknown; it includes, however, a larger proportion of carbon than most other organic substances—every 100 parts containing $58\frac{1}{2}$ of carbon.

Exposure to light increases the development of these pigment cells, as is seen in freckles, tan, and the swarthy hue obtained by exposure in tropical climates. The latter, operating through successive generations, is doubtless the cause of the blackness of the negro's skin.

The *nails* and *hairs* are also modifications of epidermic cells — for *description of which see Anatomy.*

The *epithelium* is the layer of cells which covers the internal free surfaces of the body. In some instances it serves, as in the epidermis, to protect the subjacent membranes; in others, it takes an important part in some of the organic functions. Of all the different forms of organic cells, the epithelium cells are probably most rapidly reproduced; it is supposed by some observers that a complete *cast* of the

mucous membrane of the alimentary canal is thrown off every 24 hours, whose constitution is entirely of cells. These cells are invariably replaced by others.

In the arrangement of the epithelial cells, two principal forms are seen, viz.: the *tessellated* or *pavement-like epithelium ;* and the *cylindrical,* or *cylinder epithelium.*

The tessellated covers the serous and synovial membranes, the lining membrane of blood-vessels, and the ultimate follicles or tubuli of the glands connected with the skin or mucous membranes. It is called *tessellated,* from the fact, that the cells which compose it are polygonal, and arrange themselves like the pieces of marble in a tessellated pavement. Sometimes, however, the cells retain their rounded form, and are separated by considerable intervals (Fig. 165).

The *cylinder epithelium* is so called because the component cells are cylinders, and arrange themselves side by side, one extremity resting on the basement membrane, while the other forms part of the free surface. It is found in the mucous membrane of the alimentary canal, from the cardiac orifice downwards; in the larger ducts of the glands which open into it; or, upon the external surface.

Both these forms of epithelium are frequently seen to be fringed at their free extremities with delicate filaments, termed *cilia,* from their resemblance to an eyelash. These, although exceedingly minute, are of great importance in the economy, through the extraordinary motor power with which they are endowed (Fig. 166). In form the cilia are usually a little flattened, and tapering gradually from base to point. Their size is variable, ranging from 1-5000th to 1-13000th of an inch in length.

Fig. 165.

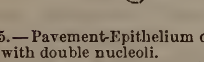


Fig. 166.

Fig. 165.—Pavement-Epithelium of the Mucous Membrane of the smaller bronchial tubes; *a*, nuclei with double nucleoli.

Fig. 166.—*a.* Nucleated cells resting on their smaller extremities; *b.* Cilia.

When in motion they present the appearance of a field of whea over which the wind is blowing, first depressed, and then returning to its original state. The direction of this motion is towards the outlets.

The *cause* of ciliary motion is unknown; it is not dependent on muscular action, since it continues after separation, and contains not even a fibrilla of muscle. It seems to be entirely independent of muscular influence, and of both the vascular and nervous systems. It

continues many hours after separation from the rest of the system has taken place, and when all supply of blood to the parts endowed with it has been cut off. It resists the action of narcotics, which affect powerfully the nervous system; and even electricity, which destroys muscular contractility, does not affect the action of cilia. It continues much longer in cold-blooded than in warm-blooded animals. The *function* of the cilia seems to be, to propel the secretions, which would otherwise accumulate on these membranes, towards the outlets. In some of the lowest animals cilia are found in the interior of the blood-vessels; in these they are the active agents in carrying on the circulation, the blood corpuscles being carried from one to another, as the secretions are in other parts of the mucous membrane.

These cilia have also been called *vibrillæ,* a name which much better expresses their function.

The epithelium cells, like the epidermic, are being constantly cast off and renewed from the subjacent surface; but the rapidity of this renewing process varies according to the particular function of the part.

OF THE COMPOUND MEMBRANO-FIBROUS TISSUES.

This division includes the structures made up of the elementary components of the body, viz.: membranes, fibres, and cells, in their simplest forms. These are the serous, synovial, and mucous membranes.

The serous and synovial membranes are essentially alike in their minute structure. On their free surface is a single layer of *epithelium,* the particles of which are polygonal in shape, and of transparent texture. This rests upon a continuous transparent *basement membrane* of extreme tenuity. Beneath this is a layer of *areolar tissue,* which constitutes the chief thickness of the membrane, and gives it its strength and elasticity. This areolar tissue is traversed by a network of capillary vessels, lymphatics, and nervous filaments in varying number; and is the bond of union with the tissues beneath. It is commonly known as the *subserous tissue.*

The physical and vital properties of serous membranes are precisely those of areolar tissue. They are elastic, but not contractile, and have very little sensibility, except when inflamed. They are bedewed with a secretion which resembles the serum of the blood. That of the synovial membranes and bursæ mucosæ has from 6 to 10 per cent. of additional albumen. It escapes from the blood-vessels by simple *transudation.*

Serous membranes are recognised by the fact, that they always form shut sacs. The peritoneum of the female is the only exception to this rule. At two points this membrane is open, where it communicates with the canal of each Fallopian tube at its dilated extremity.

The *mucous membranes* may be said to consist of the three parts described in the serous, viz.: *epithelium, basement membrane* and the

submucous areolar tissue. The mucous membrane is continuous with the external skin, and by some is considered as identical. It is recognised by the fact that it lines the *outlets*, and never occurs as a shut sac. It is abundantly supplied with blood-vessels, absorbents, and nerves. The first two are very numerous, the last not so much so, hence the sensibility of this structure is usually low.

The areolar tissue of mucous membrane usually makes up the greater part of their thickness; and is so distinct from the subjacent layers as to be readily separated from them. The elasticity of these membranes is dependent upon the presence of the yellow fibrous tissue in the areolar tissue.

Mucous membranes are very speedily regenerated whenever they have been destroyed either by injury or disease. They constitute the medium through which all the changes are effected that take place between the living organism and the external world.

The character of the secretions of mucous membranes varies in almost every part, and is dependent upon the properties of the epithelial cells which cover them. In the ultimate tubuli of glands, these cells are found to contain the peculiar substances which characterize the secretion. They are not mere protective agents, as the epidermic cells are, but, in the case of the glands, they are concerned in elaborating their peculiar secretions, and in the mucous membrane of the small intestine, in effecting the absorption of nutrient materials.

In the brônchio-pulmonary and gastro-intestinal mucous membrane, we meet with the peculiar secretion called *mucus*, which is intended to lubricate the parts on which it is thrown out, and to protect them from the action of irritating substances. It is also found in the ducts of glands, and in the urinary and gall-bladders, but is generally mixed with the secretions of these parts.

Mucus is a viscid, colourless, or slightly yellow fluid, not miscible with water, and containing a substance called *mucin*, upon which its characteristic properties depend. This appears to be an albuminous compound, altered by the presence of an alkali. Mucus contains, also, a small proportion of solid matter, and some salts, resembling those of the blood and epithelial scales, together with peculiar corpuscles called *mucus corpuscles*. The true chemical characters of this fluid are as yet incompletely known.

OF SIMPLE ISOLATED CELLS, FORMING SOLID TISSUES BY THEIR AGGREGATION.

The cells of this class begin and end their lives as such without undergoing any transformation, but instead of lying upon free surfaces, or being cast off from them, they form part of the substance of the fabric. Two examples of this kind are found in the cells developed at the extremities of the intestinal villi, and those which exist at the terminal extremities of the hepatic ducts. Both these sets of cells

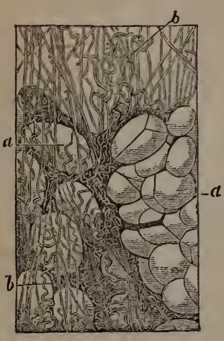
seem to have the power of *selecting* from the fluids presented to them certain materials, which they deliver up to the absorbents in one case, and the hepatic duct in the other. An analogous set of cells are found at the extremities of the fœtal tufts in the placenta, which have a like power of selecting nutritious materials from the maternal blood for the nourishment of the fœtus.

The *fat-cells*, of which adipose tissue is composed, also permanently exhibit the original type of structure in its simplest form. This tissue is usually diffused over the whole body, either in the areolar tissue, or in small clusters covered by the common envelope; and even in cases of great emaciation there is some fat always left, especially at the base of the heart, around the great vessels, &c.

Fat-cells are spherical or spheroidal; when closely pressed together they assume a polyhedral form. Large masses of fat are often formed by their aggregation, the component parts being held together by areolar tissue, and also by the blood-vessels which ramify minutely among them, forming a capillary network upon the smallest lobules, and even between the individual cells. This tissue contains neither lymphatics nor nerves. (Fig. 167.)

The *fat* is contained in the interior of these cells, where it is deposited from the blood-vessels. Its consistence varies according to the proportion of the organic elements entering into its composition. These are elaine or oleine, stearine, and margarine; the last two, which are solid when separated, being dissolved in the former at the ordinary temperature of the body. The oil thus formed in the interior of the cells is prevented from escaping, by the moistening of the cell-walls by the watery fluid circulating through the vessels. All the substances above named are regarded by chemists as *salts*, being compounds of the oleic, stearic, and margaric acids with a base, the oxide of lipyl.

Fig. 167.



Areolar and Adipose tissue; *a, a,* fat-cells, *b, b,* fibres of areolar tissue.

The fat is analogous to the starch of vegetables, and has a like use, viz., to supply elements of nutrition, when other sources are cut off. It also answers the important purpose of retaining the animal temperature by its non-conducting properties; and the still more important object of serving as a kind of reservoir of combustible matter against the time of need. Fat appears to be deposited only when an excess of non-azotized alimentary matter is introduced into the body, over and above the wants of the system.

Cartilage in its simplest form consists merely of nucleated cells, and greatly resembles the cellular tissue of plants. In other forms,

however, the cells are imbedded in an intercellular substance, or *matrix*, called *chondrine.* This substance bears a strong resemblance to gelatine, but requires longer boiling in water to effect its solution. It is not precipitated by tannic acid, but *is*, by acetic acid, alum, acetate of lead and proto-sulphate of iron. It agrees more nearly with the proteine-compounds in composition, than gelatine, and may be considered as an intermediate stage between the two.

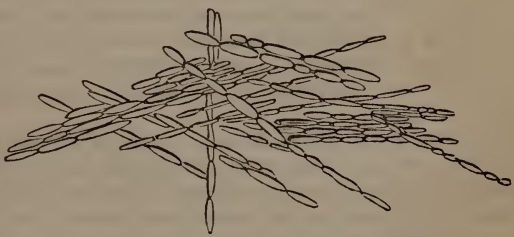
Cartilage, in general terms, may be considered a *non-vascular* substance, considerable masses of it existing unpenetrated by a single vessel. They are, however, surrounded by numerous blood-vessels, which form large *ampullæ,* or dilatations at their edges, or on their surfaces, from which they derive their nourishment by imbibition.

Cartilage is insensible; neither nerves nor lymphatics can be traced into its substance, and it is doubtful whether it is ever replaced by a similar structure when once destroyed.

Fibro-cartilage is a compound of white fibrous tissue and cartilage in varying proportions. When the intercellular substance assumes a fibrous arrangement, surrounding the cells, it is known by this name. In some instances the fibrous structure is developed so much at the expense of the cells, that the latter disappear altogether, and the whole structure becomes fibrous. This structure is seen in all those cartilages which unite the bones by synchondrosis, as in the vertebral column and pelvis. The *reticular* structure is seen in the concha auris and in the epiglottis.

The *cornea*, according to the researches of Messrs. Todd and Bowman, is a peculiar modification of the white fibrous tissue, in which the fibres, which in the sclerotic have been densely interlaced, flatten out into a membranous form, so as to follow the curvatures of the cornea, and constitute a series of more than sixty lamella, united to one another by delicate processes extending from one to the other. The resulting areolæ lie in superposed planes, the contiguous ones of the same plane being for the most part parallel, but crossing those of the neighbouring planes at an angle, and seldom communicating with them. (Fig. 168.)

Fig. 168.



The *crystalline lens* has long been known to be fibrous. The fibres are united into laminæ by means of numerous teeth or sinuosities at their edges, which lock into one another. They originate in cells,

several of which coalesce to form one. After the lens is fully formed it is not permeated by blood-vessels; these being confined to the capsule. It consists chiefly of albumen in its soluble form, and is coagulated by heat. The latest analyses represent the substance of the lens as consisting of that modification of albumen called globuline. The *vitreous humour* is an example of a very loose form of cellular tissue. The cells have no open communication with each other, and contain a fluid holding a small quantity of albumen and saline matter in solution. It is nourished by the vessels which are minutely distributed upon its general surface, there being none distributed through its substance for this purpose.

TISSUES CONSOLIDATED BY EARTHY DEPOSIT.—BONES AND TEETH.

For a full description of these tissues, see ANATOMY. Articles Bone, Teeth.

SIMPLE TUBULAR TISSUES.

Of these we have examples in the smaller capillary vessels, and probably also in the smallest lymphatics and lacteals. They seem to be formed by a coalescence of the cavities of the cells, produced by the absorption of the cell-walls at the point of contact.

In all the higher animals, in their adult condition at least, the capillary circulation is carried on through tubes having distinct membranous walls. These tubes are formed from cells, like the straight and anastomosing ducts of plants. In the walls of these tubes cell-nuclei may be constantly found; and these are too far apart to warrant the idea, that they are the nuclei of epithelial cells, such as line the larger vessels.

These vessels have a claim to be regarded among the elementary parts of the fabric, since they are formed independently of the larger trunks, and have little in common with them in function. All those changes which take place between the blood and surrounding parts, by which nutrition, secretion, and respiration are accomplished, occur during the movement of the blood through these vessels, the larger vessels merely bringing to them a constant supply of fresh blood, and conveying from them that which has been impoverished in the foregoing processes.

The diameter of the capillaries varies in different animals according to the size of the blood-corpuscles. Thus, they are larger in the frog than in man, in whom they average from 1–3700th to 1–2500th of an inch. In the living subject, it may be stated, they may be seen to vary their diameter at different times, so as to accommodate themselves to the varying supply of blood. They seem to have a distributive power of their own, entirely independent of the heart's action, but influenced by the attraction existing between the tissues and the constituents of the blood. The capillary vessels are first formed in the *vascular layer* of the germinal membrane, entirely by the coales-

cence of cells, which send off prolongations in various directions, like the radii from a star. By the junction of these prolongations a net-work of tubes is formed, at first, irregular in size, but afterwards becoming more equalized.

In newly-forming tissues, much the same arrangement takes place, the prolongations coming in contact with the vessels of the surrounding parts.

The opinion, that the *white tissues* are nourished by vessels conveying white blood is no longer tenable. Some of the white tissues, such as cartilage, are entirely destitute of vessels; and in others the supply of blood is so scanty, as not to communicate to them any decided hue. What have been considered as white vessels, are merely those of very minute size, which, admitting only a single row of blood corpuscles, do not contain a sufficient amount of colouring matter to affect the light transmitted through them.

COMPOUND TUBULAR TISSUES.

Examples of these are seen in the *muscular* and *nervous* tissues, in which, after tubes have been formed by the coalescence of the cells, their interiors are filled up with a secondary deposit. The functions of these two tissues are widely different. The *muscular* is that by which all the sensible movements of the body are effected. The *nervous* is that by which impressions are received; and by which the instincts, emotions, or volitions excited by sensation, act upon the muscles.

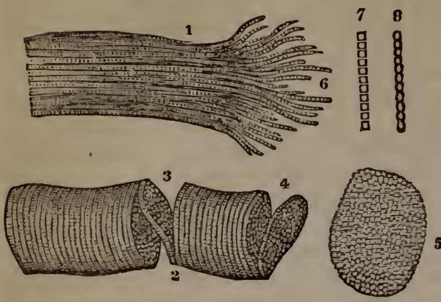
The ultimate structure of these two tissues is alike; both consist of *tubes* formed by the coalescence of cells. The difference between them exists in the nature of the internal deposit.

There are two forms of muscular tissue,—in one the ultimate fibrils are marked by transverse striæ, or bands; in the other, they are plain, or unstriped. The former, or the striped fibres, are found in all the voluntary muscles, or, as they are sometimes called, the muscles of animal life. The latter are seen in those muscles which are concerned in the organic or vegetative functions. They are not so readily called into action through the agency of the nervous system, as the striped muscles, but are more readily excited by stimuli applied directly to themselves.

An ordinary muscle is seen, even by the naked eye, to consist of bundles of fibres, arranged with great regularity, in the direction in which the muscle is to act. These fibres are arranged in *fasciculi*, or bundles, connected together by means of areolar tissue. Each fibre presents two sets of markings, or striæ, one set *longitudinal*, the other *transverse*. By close examination the individual fibre may be separated into fibrillæ by the splitting of its contents in a longitudinal direction. (Fig. 169.) These fibrillæ present a *beaded* appearance, caused by the peculiar arrangement of the contents of the tube.

It frequently happens, that when force is applied to a fibre, its con-

Fig. 169.



1. Longitudinal cleavage. 2, 3, 4. Transverse cleavage, forming disks. 5. A detached disk, showing the sarcous elements. 7, 8. Separated fibrillæ, showing the beaded enlargements.

tents separate in the direction of the transverse striæ, quite as frequently as in the longitudinal direction, thus forming a series of *disks* as seen in Fig. 169. If a general disintegration took place along all the lines in both directions, there would result a series of particles, which have been called *primitive particles* or *sarcous elements*, the union of which constitutes the mass of the fibre.

According to the opinion of Messrs. Todd and Bowman (in which they are supported by Müller, Lauth, and Schwann), the cross-stripes of the fibres are formed by the apposition side by side of the dark points seen on the separated fibrillæ.

The elements of the muscular fibres are held together by a tubular sheath adapted to its surface and adhering to it; this is called the *sarcolemma* or *myolemma*. It is a transparent, very delicate, but tough and elastic membrane, which isolates the fibre from all other tissues. It has nothing to do with the production of the transverse striæ. Neither is it perforated by nerves or blood-vessels.

Muscular fibres are rather polygonal than cylindrical, owing to the pressure to which they are subjected by juxtaposition. Their average diameter in man is about 1-400th of an inch, being rather larger in the male than in the female.

The fibrillæ, when examined, are found to present an alternation of dark and light spots, corresponding with the transverse striæ of the fibre, and the lighter intervals between them. Each dark spot is surrounded by a pellucid border; the whole constitutes a complete, though minute cell, and the entire fibrilla may be considered as *made up* of a linear aggregation of such cells. The dark spot within the bright border is the cavity of the cell, filled with a refracting substance. When the fibrilla is relaxed, the longitudinal diameter of these cells is greatest; when contracted, the transverse. Thus the act of muscular contraction seems to consist in a change of form in the cells of the ultimate fibrillæ, consequent upon an attraction between the walls of their two extremities or their nuclei. This corresponds with the contraction of certain vegetable tissues, the component cells of which change their form when irritated, and thus produce a movement.

When muscular fibre contracts, therefore, it is not thrown into

zigzag lines, since fibres in this state, cannot be supposed to exercise any force of traction, but it is shortened in length by the approximation of its elements, at the same time that the transverse diameter is increased.

Muscles grow by an increase, not of the *number*, but of the *bulk* of their elementary fibres; the number of fibres probably remains the same through life, as it was in the fœtus. Notwithstanding the energy of its growth, and the constant interstitial changes, it is doubtful whether muscular tissue is ever regenerated where loss of substance has taken place. It is generally replaced by areolar tissue, which gradually becomes condensed, but never *contractile.*

The great property of muscular tissue is that of *contractility*, by which is meant, *the power of moving responsive to irritation.* It is not the mere mechanical power by which elastic substances shorten themselves on the removal of a distending force, but it is an endowment responsive to appropriate stimuli, and diminishing or disappearing with the healthy state of the tissue. Elasticity is a mere physical property. Contractility is a *vital* property.

Whatever is capable of inducing contraction in muscles, when applied to them, is called a stimulus. Chemical agents, mechanical applications, and irritating substances are included under this head. The influence that carbonic acid exerts upon the contractility of muscular fibre admits of some question. It is the generally received opinion that this gas exercises a sedative influence upon them, and arrests the power of being excited to contraction. Some recent experiments of the author show, however, that the presence of this agent in the blood may excite movements. On opening the cavity of the abdomen of an animal while living, the peristaltic movement is barely perceptible; if now partial asphyxia be produced by strangulation, the peristaltic action is manifestly increased, again to disappear on the restoration of the respiratory function. The convulsions of epilepsy attended with laryngismus, and the spasmodic struggles of a suspended criminal, point to the same source of stimulation. In the latter case, the movements of the heart are known to continue long after respiration has ceased, so also in asphyxia produced by coal gas, or by drowning.

In cholera asphyxia, where the patient has died after a short illness, and unattended by cramps, many practitioners have noticed convulsive twitchings and movements after somatic death, which may be explained by the presence of carbonic acid in large quantities in the vessels, acting as an excitant to muscular contractility.

In the living body the ordinary stimulus exciting contraction is the *nervous influence.* Muscular contraction, however, is not *dependent* on this influence, since it can be excited after all connexion with the nervous centres has been destroyed, and even in a single isolated fibrilla.

The contractility of a muscle may be exhausted by repeated exercise, as well as by the continued application of any of the above

stimuli, but it may be recovered again, provided a sufficient interval of rest be afforded to it. "In regarding contractility, therefore, as a property of living muscular fibre *in general*, it is meant that it resides in it as a property, without which it would not be muscle; and in such a manner, that no particle, however microscopic, can be detached from a muscle which does not of itself, and independently of the rest, possess this property as long as it possesses vitality."

Muscles are abundantly supplied with blood-vessels and nerves. The capillary vessels ramify in the spaces between the fibres, but never penetrate the sarcolemma, the nutritive materials being probably supplied by the selecting power of cells. The nerves are *motor nerves*, and they are exceedingly abundant, terminating usually in the substance of the muscle *in loops*. The muscles of *organic* life are but little influenced by nervous power, but depend for their stimulation upon the presence of substances brought immediately into contact with them. The muscles therefore have but little senibility.

Every fibre of striated muscles is attached by its extremities to white fibrous tissue; through the medium of which it exerts its contractile power on the bone, or other substance to be moved; the union of all these white fibres constitute the *tendon*. The muscular fibre ends by a perfect disk, and with the whole surface of this disk the tendon is connected and continuous with it and the sarcolemma.

Muscular contraction is accompanied by the production of *sound* and *heat*, both of which are probably produced by the movements of the neighbouring fibres upon each other. The heat may also be produced by the chemical changes resulting from the disintegration of the muscular tissue consequent upon its use. This elevation of temperature is sometimes as high as 2° Fahr. Muscular contraction also developes *electrical currents*, which may be readily recognised by appropriate instruments, and may be made the process of exciting contractions in other muscles, if a communication be established between them, as by a piece of nerve, for instance, dissected from the leg of a recently killed frog, and introduced into an incision in a contracting muscle.

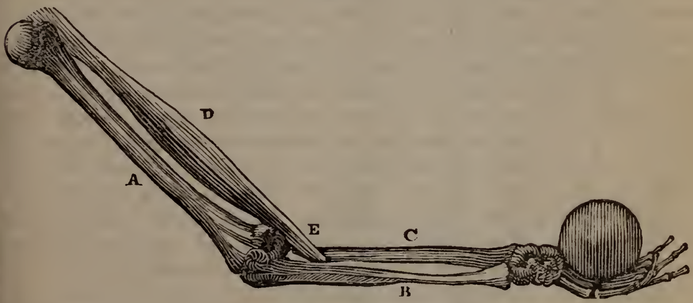
The *rigor mortis*, or the stiffening of the body after death, is due to the contraction of the muscles, and, like the coagulation of the blood, is the last act of their vitality. Where the individual has died of a wasting disease, it comes on early, and lasts but a short time, and the reverse obtains where death has occurred during full health. Cadaveric rigidity may supervene before death, as seen in an instance related to the author by one of his friends, of a soldier dying of an extensive phlegmon in one arm. Rigidity was plainly discoverable in the unaffected limbs while the movements of the heart were being examined and counted. As the rigor mortis comes on, the contractility of the muscle departs. Its cause is obscure, and may be complex, but its resemblance to the contraction of fibrine after recent coagulation is strongly marked.

In every case muscular action must alternate with intervals of rest. It is in these intervals that the reparation of the disintegrated tissue takes place, and that the muscle recovers its contractility.

The mechanical arrangement of the muscles upon the skeleton is usually accompanied with a loss of power, but with a gain of velocity. The locomotive framework may be regarded as a series of levers, of which the fulcrum is generally a joint. In most cases the muscles are attached near the fulcrum, as in the biceps. By this arrangement a contraction of a single inch in the muscle, moves the hand through the extent of a foot, but then the hand moves only with one-twelfth of the power exerted by the muscle.

When a muscular fibre, the opposite extremities of which are attached, for example, to adjacent points of two bones, is made to

Fig. 170.



BONES OF ARM, HOLDING WEIGHT.

shorten itself forcibly by the application of a stimulus, the more moveable point is drawn nearer to the more fixed point; and this is the great law on which locomotion by muscular fibres depends. Thus the fore-arm is bent upon the arm by a muscle, D, which arises from the top of the latter, and which is inserted at E, at a short distance from the elbow-joint. A very slight contraction will raise the hand, but a considerable increase of power is required to overcome a resisting force.

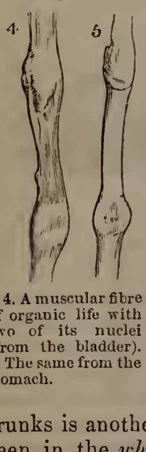
Tonicity. — There is another form of muscular contraction, which may or may not be the result of the same property, modified by a difference of circumstances. In past times, however, it has been regarded as a different property, and is known by the name of tonicity. The character of this so-called property of the muscular fibre is better taught by examples than by description. If a muscle in the living body be cut right through, each portion, after a few quivers, begins slowly to shorten itself in a permanent manner, so that an empty space is left between the two cut extremities. There being no tendency in these two shortened portions to return to their former length during

an indefinite term, this effect has usually been ascribed to a property different from contractility, under the name of tonicity. Whenever, by any change of the relative natural position of the parts of the skeleton, as by fracture or dislocation, the points to which the opposite ends of a muscle are attached are brought nearer to each other, the muscle becomes permanently shortened by the same so-called tonicity. Again, if the muscles which extend or straighten a joint become paralysed, without a corresponding loss of power in the antagonistic muscles which bend that joint, then the flexor muscles, as they are termed, become shortened by their tonicity, and the joint remains permanently bent. This explains the permanent bent state of the elbow-joints in the paralysis of the upper extremities attendant on the painter's colic, to which all artisans are exposed whose occupations bring them into daily contact with preparations of lead.

Some forms of permanent lock-jaw seem to be of the same character; the muscles closing the jaw, which correspond to flexors, remaining in full vigor, while their antagonists have lost their power.

The muscular fibres of *organic life* are very different, not only in structure, but also in function, from those already described. They consist of a series of tubes, which are not marked by transverse lines, and in which the longitudinal striæ are very faint. These tubes are usually much flattened, and cannot be shown to contain distinct fibrillæ. They are generally smaller than those of animal life, and sometimes present markings indicative of a granular deposit. The nodosities upon their surface are the nuclei of their original components. (Fig. 171.) The peculiarity of these fibres is, that they are very little subjected to nervous influence, and that when stimulated to contraction by an irritant, they perform a series of vermicular movements gradually decreasing in intensity till perfect rest takes place. They are found in the intestinal canal, ducts of glands, middle coat of the arteries and bronchial tubes, &c.

Fig. 171.



4. A muscular fibre of organic life with two of its nuclei (from the bladder). 5. The same from the stomach.

The *Nervous structure* as it appears in the nervous trunks is another example of tubes with a secondary deposit. This is seen in the *white* or *fibrous matter*, wherever it occurs in the body, and also in the fibres of the *great sympathetic*. In the ganglia we find the other form of nervous substance, known by the name of the *gray* or *vesicular*. Wherever these two kinds are united together they constitute a *ganglion* or *nervous centre*.

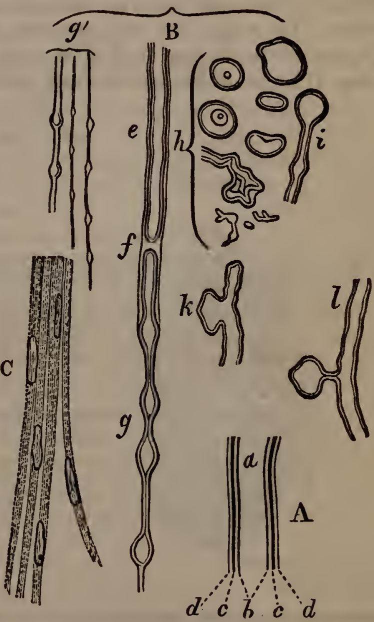
The ultimate nerve-fibre — such as is seen in the spinal nerves — is distinctly tubular. It consists of an external thin and delicate membrane, which is nearly or quite homogeneous. It forms one complete sheath, isolating the contained matter in its whole course from

its central to its peripheral extremity. This is called by Todd and Bowman the *tubular membrane.*

Within the tubular membrane lies a more opaque substance, known as the *white substance of Schwann,* and within this again is a transparent material, which has been called the *axis cylinder.* The whole of the contained substance is exceedingly soft, and may be made to pass from one part of the tube to another. A bundle of nerve-fibres, surrounded and connected by areolar tissue, constitutes a nerve.

The other form of fibrous matter is that which is seen in the great sympathetic system, and which is known as the *gelatinous nervous fibre.* These fibres contain nothing analogous to the white substance of Schwann, and are devoid of the whiteness which characterizes the tubular fibre. The gray colour of certain nerves depends upon the presence of a large proportion of gelatinous fibres. Hence, they are sometimes called *gray fibres.* They are smaller in diameter than the tubular fibres, ranging from $\frac{1}{6000}$ to $\frac{1}{4000}$ of an inch. (Fig. 172.)

Fig. 172.



A. Diagram of tubular fibre of a spinal nerve:—*a.* Axis cylinder. *b.* Inner border of white substance. *c, c.* Outer border of white substance. *d, d.* Tubular membrane. B. Tubular fibres; *e,* in a natural state, showing the parts as in A. *f.* The white substance and axis cylinder interrupted by pressure, while the tubular membrane remains. *g.* The same, with varicosities. *g'.* Varicose fibres of various sizes, from the cerebellum. C. Gelatinous fibres from the solar plexus, treated with acetic acid to exhibit their cell-nuclei.

The remaining element of the nervous structure is what is called the *gray* or *vesicular.* This is found in the *nervous centres,* but never in the nerves, properly so called. It consists of *cells* or *vesicles* containing *nuclei* and *nucleoli.* The walls of each vesicle are extremely thin and delicate, and contain a soft but tenacious granular mass. In some vesicles we find a number of pigment granules exterior to the nucleus, giving a dark colour to a portion of the vesicle. The gray colour is not essential; it is merely produced by the peculiar character of the pigment cells. In some animals they

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are red, in others green, and in others white. In the latter there is no pigment.

Another form of nerve vesicle, is that called the *caudate*, which is characterized by one or more *tail-like* processes extending from it. They contain nuclei and nucleoli, and pigment granules. Of the mode in which the fibrous material terminates in the vesicular matter of the centres to which it passes, no general statement can, as yet, be made; but it is quite certain, that, in many instances at least, there is an absolute continuity from one form of nerve-tissue to the other. Three principal modes have been ascertained in which this may occur. Either a globular cell may give off a simple prolongation that becomes a fibre, as seen at *a*, fig. 173, in which case the cell is said to be '*unipolar*.' Or a ganglion-cell presents itself, as it were, in the course of a nerve-tube, having each of its extremities prolonged into a fibre, as in fig. 174; in which case the cell is said to be 'bipolar.' In certain

Fig. 173.

Microscopic Ganglion from Heart of Frog, showing, at *a*, a *Unipolar Ganglionic Cell.*

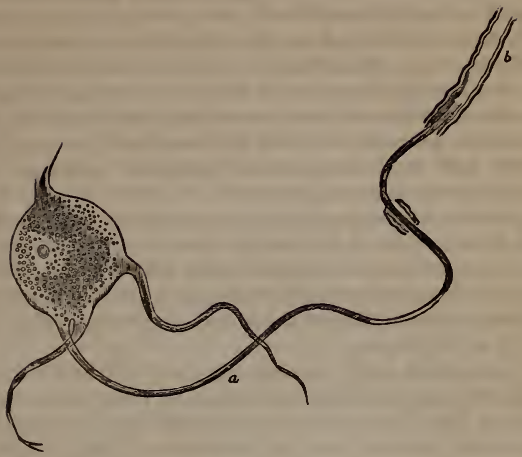
Fig. 174.

Bipolar Ganglionic Cells and nerve-fibres, from Ganglion in 5th pair in Lamprey.

parts of the nervous centre of man, are seen ganglionic cells sending out prolongations to the number of three, four, five, six, or more, some of which are occasionally to be traced into continuity with the axis cylinder of nerve-tubes, as seen at *a*, *b*, fig. 175; whilst others, it is probable, inosculate with those of other stellate cells. Other communications are established, however, by spheroidal cells lying simply in juxtaposition with fibrous material, either side by side, or in loops formed by plexuses of the latter.

The *fibrous* matter is produced, as the muscular fibre, by the coales-

Fig. 175.



Stellate Ganglionic Cell, from "substantia ferruginea" of Human Brain; one of its prolongations, *a*, becoming continuous with the axis-cylinder of a double-contoured nerve-fibre, *b*.

cence of cells, in which a secondary deposit takes place. The *vesicular* by a succession of cells like those of epithelium.

The chemical constitution of nervous matter is as follows:

Albumen	7·00
Cerebral fat. { Stearine, 4·53 / Elaine, 0·70 }	5·23
Phosphorus	1·50
Osmazone	1·12
Acids, salts, sulphur	5·15
Water	80·00
	100·00

(*Vauquelin.*)

The amount of phosphorus varies at different times of life, and is exceedingly small in idiotcy. According to L'Heritier's analysis, the *minimum* is found in infancy, old age, and idiotcy; and the maximum of water in infancy.

The *nervous structure*, like the muscular, is constantly undergoing the process of disintegration and renewal, every exercise of this system being accompanied by a loss of its substance, requiring new material to compensate for it. This renewal takes place in the intervals of rest. As in the muscular system, its waste is represented by the amount of urea in the urine, so in the nervous system, is its waste represented by the amount of phosphatic depositions; the latter being always increased under mental exercise. Persons, therefore, whose

mental faculties are much employed, require as nutritious a diet as those who gain their "living" by the sweat of their brows.

In regard to the regeneration of nervous structure when it has been destroyed, it is now believed, on the authority of Schwann, Steinruch, Brown-Séquard, and Nasse, that the *white* or *tubular* matter may be restored, they having discovered, that in the uniting substance between the ends of a divided nerve, true nerve-fibres may be developed. Perfect restoration, however, does not always take place, owing most probably to the fact, that the central and peripheral portions of the same fibres do not always meet again.

In regard to the *gray* or *vesicular* matter we are not so well informed. When a portion of the brain is removed in animals, its place is supplied by new matter; but whether this becomes true cerebral substance remains to be proved; from the great activity of its nutritive processes, however, there seems reason to believe that its loss is repaired by similar matter.

Those nerve-fibres which originate in the brain, and are distributed to the muscles, have no proper *termination;* they form *loops*, which either return into themselves, or join others formed by the ultimate ramifications of the main trunks. They never anastomose with each other, but each runs a separate and distinct course. Those fibres which originate on the periphery and run towards the brain and spinal cord, also form loops in these centres.

Wherever the *vesicular* matter is found, it is looked upon as a *generator* or *originator* of nervous influence; whilst the *white* or *tubular*, is the *carrier* of that influence to the various parts of the system. The former, having the higher set of functions, receives by far the larger quantity of blood.

Plexuses are formed by the free interchange of fibres from several neighbouring nerves. Four or five nerves, for instance, proceed from the spinal cord and are plaited up together like the strands of a coach whip. From the plexus thus formed, certain nerves emerge which are composed of fibres from several of the original trunks. The advantage of this arrangement is, that not only are nerves of different endowments joined together, but the injurious effects which would otherwise result from lesion of the spinal cord, are obviated; for the nerves which come off below the injured part, all receiving filaments from those which are above, the nervous influence is thus transmitted unimpaired to all those parts supplied by filaments from below the point of lesion.

OF THE DEVELOPMENT OF TISSUES FROM CELLS.

It has been seen that there is reason to doubt whether cells are concerned in the development of *all* the tissues, further than in the part which they take in elaborating the fluid from which the tissues are derived, some of the structures seeming to be produced by a consolidation of the plastic fluid which has been elaborated by their

agency. Many of the component structures, however, owe their development to the agency of cells, and of these we shall now speak.

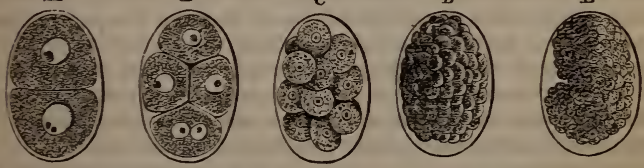
Cells are formed, either in a previously existing, structureless fluid, called a *blastema* or within the interior of previously-existing cells by duplicative subdivision, or by the expansion of a nucleus. In the first method, when a plastic fluid is in contact with a living structure it is seen to become opalescent; this change in colour is owing to the deposition within it of a number of small granules called *nucleoli;* several of these aggregate themselves together and form what is called the *nucleus*, within the interior of which the *nucleolus* can still be seen. This nucleus is also called the *cytoblast* (from κυτος, a vesicle, and βλαςος, a germ), or *cell-germ.* From the side of this nucleus a thin transparent membrane is next seen to project in the manner of a watch-crystal from the dial; this gradually enlarges till at last the nucleus is seen only as a spot on its wall. The whole is then called a *nucleated cell*, or *germinal cell.* The fluid in which the granules are first deposited is called the *cytoblastema.* (Fig. 176.)

In the *second* method, or the *endogenous* development as it is called, the *nucleus* seems to perform an important office. Each granule of which it has been shown to consist, has the power of developing a cell, so that the parent cell becomes filled with one or more generations of new cells, which may either disappear entirely, as in the case of the ovum, or by the rupture of the original cells the contents may be scattered and undergo an independent development. (Fig. 177.) Sometimes several nucleoli are seen within one nucleus; and sometimes several nuclei within one cell.

Fig. 176.

Plan representing the formation of a nucleus, and of a cell on the nucleus, according to Schleiden's view.

Fig. 177.



Endogenous development of cells—A, B, C (from Kölliker), ovum of Ascaris nigrovenosa; D and E, that of Ascaris acuminata (from Bagge).

Another mode of cell-formation occasionally occurs; to wit, the expansion of a single apparently homogeneous granule into a cell without the previous formation of any perceptible nucleus; a distinction first showing itself between the exterior portion of the granule, which becomes the cell-wall, and the interior, which seems to melt down to

form the first cell-contents; and the former extending itself as the latter augment by imbibition from the surrounding fluid.

Cells are concerned not only in the function of nutrition in the development and restoration of parts, but also in several other organic processes. In nucleated cells, also, are the best examples of inherent formative power, which, not being consumed in the formation of the cells, remains operative in them, changing them and their contents, and influencing the surrounding or intercellular substance in which they are deposited. Thus, whether it be for the preparation of materials from food which may serve to the maintenance of the body, or for the construction of the several tissues, or for the formation or temporary storing-up of the materials that are to be removed from the body as refuse, in all these, and in nearly all instances of them, the end is attained by or with the help of the formation, continued energy, or dissolution of nucleated cells.

Each cell is an independent organ; it lives *for itself* and *by* itself, and is dependent upon nothing but a due supply of nutriment and of the appropriate stimuli for the continuance of its growth and for the due performance of its functions, until its term of life is expired, just as one man is able to support himself alone; but as the cells become commingled into organisms, a division of labour, or separation of functions, becomes necessary, just as in a community of men there must be hewers of wood and drawers of water. The nucleus and cell-wall differ from each other in chemical composition, though both seem to be concerned in the development of tissues. The cell-wall is a proteine-compound.

In the formation of tissues, the cells undergo changes which may be described under two heads: *first*, Those affecting the cell-membrane; and *secondly*, Those in which the nucleus is concerned. In the fibrous tissues, the cell-membranes become elongated, and so folded and divided as to give the appearance of subdivision into minute threads or fibres. In the compound tubular tissues, as muscle and nerve, the cells are joined end to end, and the partitions at each extremity being removed, a tube is formed, in which the proper deposit of muscular or nervous matter takes place.

In the simple tubular tissues, as in the capillaries, the tubes are also formed by the coalescence of the walls of the cells at several points, owing to their elongation, here and there, into pointed processes, which unite and form the ramifications of the vessels.

The metamorphoses of the nucleus, although equally important, are much less numerous. In some cases it sends out radiating prolongations, causing it to assume a stellate form, which is the case in bone cells. In other cases it appears to resolve itself into a fasciculus of fibres; and this, according to Henlé, is the origin of yellow fibrous tissue. The tubuli of the dental structure are formed by its separation into a number of distinct fibres, each composed of a linear aggregation of granules. Lastly, according to Dr. Carpenter, it may dis-

perse itself still more completely into its component granules, by whose reunion, certain peculiar vibrating filaments (the so-called spermatozoa), may be formed, possessing motor powers, and destined to perform most important offices in the function of reproduction.

The development of cells goes on during the life of the organism at every period of its existence. They are found floating in immense numbers in the blood, chyle, and lymph; and even in diseased secretions, as pus. In the inflammatory process they are developed in great quantities; and even the malignant growths, such as cancer and fungus hæmotodes which infest the body, owe their development to the same agencies. In short, the nucleated cell is the agent of most of the organic processes, both in the plant and animal, from the time of their earliest development, to their full maturation and decline.

PHYSICAL AND VITAL PROPERTIES OF THE TISSUES.

The tissues present manifest differences among themselves, not only in their anatomical structure but in their properties. These properties may be divided into *physical* and *vital.* The *physical* are those which are dependent solely on the peculiar arrangement or mode of cohesion of the constituent particles of the tissues as well as upon their chemical constitution, and are found as distinctly in the dead as in the living texture. The *vital* properties are those which exist only during the life of the *organism,* and which cease whenever molecular life departs.

The most striking of the physical properties, are *Elasticity, Flexibility, Extensibility* and *Porosity.*

Elasticity is that property by which a tissue reacts, after a stretching or compressing force has been withdrawn. It is strongly marked in the yellow ligament constituting the *ligamentum subflavum,* which is as elastic as India rubber. It is also seen in the middle coat of the arteries, and in the cartilage of the ribs, and on the articular faces of the bones.

Extensibility is implied in elasticity; but there are some tissues which are extensible, but not elastic; such yield only to a long-continued distending force; of this we have an example in the resistance offered by a fibrous membrane to the growth of a tumour.

Flexibility is seen in the white fibrous tissues, which are flexible, without being either extensible or elastic. We have examples of this property in *the tendons.*

Porosity. The property of permeability by fluid, is possessed by the tissues even after death, and is termed porosity or imbibition. Animal tissues owe their softness to the watery fluids which they contain, and which fill their pores.

If a solution of any salt, or of sugar, is poured into a glass tube closed below by a piece of bladder, the particles of the solution permeate the pores of the bladder, but do not pass through it. If the

tube thus filled is placed in a vessel containing distilled water, the fluid gradually rises within the tube, and sometimes to the extent of several inches, while at the same time, it is found that a portion of the solution has passed from the interior of the tube to the water external to it.

Dutrochet has named the phenomena above described *Endosmose* and *Exosmose.* The term endosmose, or *imbibition,* being applied to the current from *without* to *within,* while exosmose, or *transudation,* signifies the passage of the fluid from *within* to *without.*

In order that these phenomena may present themselves, the fluids must be of *different densities,* and miscible with each other. There must also be an *affinity* between the membrane and the fluid, otherwise no current will take place. Under these circumstances the current is most rapid, as a general rule, towards that fluid which has the *least* affinity for the septum, and it continues until the fluids are of equal density on both sides.

It is not membranes only which are endowed with this property; very thin plates of slate, or of baked clay, produce the same effect, though in a more feeble degree. Calcareous and siliceous laminæ have no effect of this kind. In membranes, endosmose is produced till they begin to putrefy, when the phenomenon entirely ceases, and the liquid which has risen in the tube descends, and filters through the membrane.

Of all the *organic substances* soluble in water, *albumen* produces endosmose with the greatest force. Various theories have been produced to account for these phenomena. Dutrochet's hypothesis, that electric action is concerned with these phenomena, has not been confirmed. The theory of Poisson, that endosmose depended on capillary attraction, is, according to Matteucci, inadmissible. "Poisson supposed that the least dense liquid entered the capillary tubes of the membrane, and that this capillary thread, drawn down by the pure water, and up by the denser liquid, must be elevated in virtue of molecular attraction. But this explanation is inadmissible, when we consider that alcohol, which is lighter than water, produces endosmose; and that certain calcareous and siliceous stones, placed under the same conditions as membranes and plates of clay, do not give rise to the same effects."* According to the same author, up to the present time there is no satisfactory theory of endosmose, though many physiologists accept that of *capillary attraction.*

"Experiment proves that the current of endosmose is not produced by the least dense liquid, nor by the most viscid one, nor by that which is endowed with the greatest force of assent in capillary tubes. The current is in general determined by the liquid which has the greatest affinity for the interposed substance, and by which it is imbibed with the greatest rapidity. In fact it is evident that the

* Matteucci's Lectures, p. 39

membrane imbibes the two liquids unequally; and that the one which is imbibed with the greatest facility, ought to mix with and augment the volume of the other."*

Poisseuille found by experiment, that there was endosmose through animal tissues, from the serum of the blood to Seidlitz water, and to solutions of sulphate of soda and common salt. This is precisely what happens when these substances are used internally as medicines: the rejected excrements contain large quantities of albumen. In this case, it must be admitted that endosmose takes place through the capillary vessels of the intestine, from the serum of the blood to the saline solution introduced into the intestinal canal. The experiments of Poisseuille have been confirmed by Bachetti, who also proved that the rapidity of endosmose is considerably increased, when one of the fluids is in motion and constantly renewed, as is the case with the blood circulating through the capillaries. The most remarkable fact discovered by Poisseuille, is that of the influence exercised by the muriate of morphia. When this substance is added to saline solutions, it very considerably weakens the endosmose from the serum to the solution, and ultimately changes the direction of the current. This has also been confirmed by Bachetti, and upon this is based an hypothesis as to the modus operandi of morphia and of the preparations of opium in diarrhœa, as well as of the constipation they produce.

The animal membranes exercise the property of *porosity* or imbibition in reference to *gases* as well as fluids; and the tendency of dissimilar gases to become diffused among each other, manifests itself even through compound textures. As was shown to be the case with liquids, there is a double current, when two dissimilar gases are separated by a porous septum, and the predominant current is that which has the greatest attraction for the septum. In respiration, this phenomenon occurs at every inspiration through the walls of the pulmonary air-cells and the plexus of capillaries distributed upon them.

It was said that all gases were not equally transmissible. The experiments of Professor Mitchell have demonstrated this fact: and the following list shows their comparative transmissibility, beginning with the most powerful: *Ammonia, sulphuretted hydrogen, cyanogen, carbonic acid, nitrous oxide, arsenuretted hydrogen, olefiant gas, hydrogen, oxygen, carbonic acid*, and *nitrogen*.

The experiments of Brunner and Valentin have led to the interesting result, that when two gases are placed on opposite sides of an animal membrane, the relative proportions absorbed and exhaled, will be inversely as the square roots of their specific gravities. Thus if we have oxygen on one side, and carbonic acid on the other side of an animal membrane, the volume of oxygen that passes inwards will exceed that of the carbonic acid that passes outwards, in the proportion of 1174 to 1000. The application of this to respiration is easy.

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* Matteucci's Lectures, p. 39.

Endosmose does not explain all the phenomena of absorption, but merely that of those fluids which require no change or elaboration; when elaboration is demanded, a vital action becomes necessary.

These properties are entirely dependent on the nutrition of their respective tissues; they quickly vary with the state of that function, and when it ceases in death, they vanish with it.

VITAL PROPERTIES OF THE TISSUES.—Some of the actions observed in living bodies indicate the operation of other properties and forces besides those which can be referred to the chemical and mechanical constitution of organized substances. These properties being the sources of phenomena which are peculiar to living beings, are named *vital properties*, the forces issuing from them, vital forces; the acts in which they are expressed, are vital acts or vital processes; and the state in which these processes are displayed is life.

The most general, perhaps a universal property of living bodies, is that which is manifested in the ability to form themselves out of materials dissimilar to them; as when, for example, the ovule developes itself from the nutriment of the fluids of the parent; or when a plant, or any part of one, grows by appropriating the elements of water, carbonic acid, and ammonia; or when an animal subsists on vegetables, and its blood and various organs are formed from the materials of its food. The force which is manifested in these acts is termed *formative* or *organic force* (assimilative or plastic force); and the processes effected by it are named *assimilative*, *nutritive*, or *formative processes.*

This power of self-formation form dissimilar materials, which appears to be wholly peculiar to living bodies, and without which, probably, none exists, manifests itself in three modes, which, though they bear different names, yet, probably, are only three expressions of one force operating in different conditions: they are *development*, *growth*, and *assimilation* or *maintenance*.

Development is the process by which each tissue or organ of a living body is first formed; or by which one, being already incompletely formed, is so changed in shape and composition as to be fitted for a function of a higher kind; or finally, is advanced to the state in which it exists in the most perfect condition of the species.

Growth, which commonly concurs with development and continues after it, is, properly, mere increase of a part by the insertion or superaddition of materials similar to those of which it already consists. In growth, properly so called, no change of form or composition occurs: parts only increase in weight, and, usually, in size; and if they require more power; it is only more power of the same kind as that which they before enjoyed.

In assimilation, or self-maintenance, living bodies preserve their condition notwithstanding the changes to which they are liable through the influence of external forces and their own natural decay; and the stability of composition which they thus display is effected by the con-

tinual formation of new particles in the place of those that are impaired and removed.

Contractility may be reckoned a second vital property. It consists in the power which certain tissues have, during life, of contracting or shortening themselves in a peculiar manner. Such contractility is usually and best observed in fibrous tissues, as in muscles and some kinds of fibro-cellular tissue; but it may be seen, also, in cells and collections of them, as in the muscles of embryos, while they yet consist of cells, and before any fibres are developed in them.

That which most characterizes the contractility of animal tissues is, that the contraction may be excited by the application of a stimulus to the nerves that ramify in them; and, indeed, it is generally through the nerves that the stimulus which produces a contraction is conveyed. In the section on the MUSCLES it was shown that the property of contractility is inherent in the tissues that contract, and is essentially independent of their nerves, so that contraction *may* take place without the co-operation of the nerves. Therefore, the whole property of *irritability*, including both the capacity of receiving a direct stimulus and the power of contracting in consequence thereof, may be ascribed to the muscles and other contractile tissues. But, in the ordinary conditions of life, the nerves may be said to be necessary to contractions, because, in these conditions it is only through the medium of nerves that a stimulus is applied to the contractile tissues, and when the nerves are destroyed contractions do not naturally ensue.

The *power of conducting* or *transmitting* stimuli or impressions constitutes another peculiar vital property. It may be said to consist in this,—that the state or change which is produced in certain tissues, as in nerve and the fibres of some plants (as the sensitive plant), by the application of a stimulus of any kind, may be propagated through the whole length of the fibre, so that every part thereof shall, with immeasurable rapidity, be brought into the same state as the part first stimulated. Thus the stimulus, or rather the change or *impression* produced by it, is said to be *conducted* in the same way as it is said electricity is conducted along a wire, although at the instant of contact with the source of electricity the whole wire becomes at once electric.[1]

The *formative* or *organic* force, to which reference has been made in preceding paragraphs, is not only the cause of all original development of the ovule, but it presides over its whole future growth, being inseparably connected with each of the successive stages of the process of nutrition. It is not self-acting, however, but depends upon certain exterior conditions for the ability to develope itself into activity. These conditions have received the name of *essential*, and are as follows:—

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[1] For a fuller exposition of this subject, see Kirke and Paget's Handbook of Physiology, Chap. III., and Carpenter's General and Comparative Physiology, Chap. III., third edition.

1st. *A germ* or nucleus, endowed with life-force, derived only from a parent.

2d. The constant presence of *nutritive material,* or *plasma,* in contact with the germ.

3d. A definite amount of *water* to give fluidity.

4th. *Oxygen,* in the proportion in which it exists in the atmosphere.

5th. *Caloric,* in a definite quantity, but varying for different genera.

All of these conditions must be *always* present, the absence of any one, for a length of time, is fatal. A certain *modification* may be compatible with *life* but not with *health.*

SPECIAL PHYSIOLOGY.

GENERAL CONSIDERATION AND CLASSIFICATION OF THE FUNCTIONS.

In every living structure of a complex nature, we see a great variety of actions resulting from the exercise of the different properties of its several component parts. A general survey of these, with reference to their mutual relations to each other, will show that they may be associated into groups, each consisting of a set of actions, which, though different in themselves, concur in effecting some positive and determined purpose. These groups and actions are termed *functions.* A function may be defined *the action of an organ or system of organs.* Thus respiration is a function; its object is the conversion of venous into arterial blood, and its instrument, the lungs.

On further examination of these functions, we find that they are susceptible of some degree of classification. There is a set which is found to be possessed by *all* living organized beings, vegetable as well as animal; these are called the *Organic* or *Vegetative.* These may be again subdivided into those concerned in the maintenance of the structure of the individual, or the *Nutritive,* and those to which the preservation of the species is due, or the *Reproductive.* There is then a set which is possessed by animals alone, in addition to those belonging to vegetables, these are called the *Animal functions* or *the functions of relation,* and are dependent for their exercise upon the existence of a nervous system, *the presence of which latter in an organized being marks the distinction between an animal and a vegetable.* The *Animal functions* render the individual conscious of external impressions, and capable of executing spontaneous movements.

These two sets of functions, the *Organic* and *Animal,* are mutually dependent on each other, the organic supplying the material necessary

for the repair of the instruments of the animal; whilst the animal functions, in which are included Sensation and Voluntary motion, are essential to enable the individual to obtain that material which the plant, from the different provision made for its support, can obtain without any such assistance. In the animal body, all the functions are so completely bound up together, that none can be suspended without the cessation of the rest.

TABLE OF FUNCTIONS.

	ORGANIC.	ANIMAL, OR OF RELATION.
Reproductive.	1. Generation.	
Nutritive.	2. Digestion.	1. Sensation.
	3. Absorption.	2. Muscular motion.
	4. Respiration	3. Mental manifestation.
	5. Circulation.	
	6. Nutrition.	
	7. Secretion.	
	8. Calorification.	

Three of these have been called the *vital* functions, viz., Innervation, Circulation, and Respiration; these constitute the vital tripod, the maintenance of which, is essential to life.

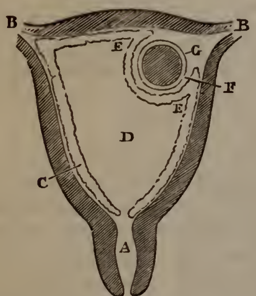
ORGANIC FUNCTIONS.

GENERATION.

By this term is understood; *that function by which the species is reproduced*, and it is effected by the union of the two sexes. There are two principal theories of generation, viz.; that of *epigenesis*, in which each parent contributes a part to the development of the new being, and that of *evolution*, in which the mother supplies all the necessary material, the male merely awakening the plastic powers resident in the female product. The popular belief is that each parent supplies material; the male, the seminal fluid, containing the *sperm-cell;* the female, the ovum, containing the *germ-cell;* that a unión of these two takes place, and from thence results the *tertium quid*, the new being. A great point of difficulty is, as to where this union takes place; some contending that it is in the ovaries, others, that it occurs in the uterus; the ovum having been previously discharged from the ovary, meeting the male sperm at that place. According to the observations of Mr. Coste, the ovule undergoes disintegration within ten or twelve hours after extrusion from the ovary. This would seem to confirm the doctrine of ovarian impregnation, or, at least, impregnation high up in the Fallopian tube, but there are physical obstacles which would seem to prevent this, viz.; constriction of the Fallopian tubes at the uterine end, downward peristaltic action, and ciliary movement in the tubes. The only point that seems entirely settled, is the necessity of *actual contact*, mere *aura* not being sufficient to effect fecundation. The

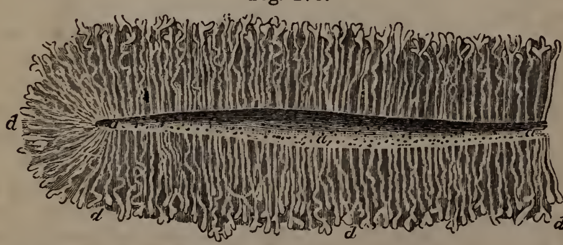
immediate result of this contact, or of successful intercourse, is the production of great excitement and vascular turgescence of the uterus. ovaries, and Fallopian tubes, which lasts for some time. After fecundation has taken place, both ovum and uterus undergo changes, the ovum developing itself by its own plastic action upon the materials it derives from the mother, at first by absorption through the villi of the chorion, and afterwards by the placenta, and the uterus increasing in size, and producing upon its interior face a membrane called the *caducous*, or *deciduous*, the formation of which has been variously explained. According to Dr. W. Hunter, the whole interior of the uterus becomes coated with a pulpy fluid, which covers over the cervix and Fallopian tubes; this becomes hard, and resembles coagulated lymph, and is called the *decidua vera.* As the ovum now descends the Fallopian tubes on its way to the uterus, it comes in contact with this membrane at the orifice of the Fallopian tubes, and pushes it before it, at the same time that it is reflected over itself, thus forming the *decidua reflexa.* (Fig. 178.) It appears, however, from the late researches of Dr. Sharpey and Professor Weber, that the decidua is really composed of the inner portion of the mucous membrane of the uterus itself, which undergoes a considerable change in its character. Dr. Reid has described a tubular structure on the free surface of the uterus, which becomes thickened and increased in vascularity within a short time after conception; and when the inner surface of a newly-impregnated uterus is examined with a low magnifying power, the orifices of its tubes are very distinctly seen, being lined with a white epithelium (Fig. 179.) This is perhaps the more correct view, since

Fig. 178.



A, neck of womb; B, orifice of left Fallopian tube; C, decidua vera; D, cavity of the womb; E, E. decidua reflexa; G, ovum; F, chorion.

Fig. 179.



Section of the *Lining Membrane* of a *Human Uterus*, at the period of commencing pregnancy; showing the arrangement and other peculiarities of the glands, *d, d, d,* with their orifices, *a, a, a,* on the internal surface of the organ.

the decidua reflexa is found to be different in its structure from that of the decidua vera, which would not be, were they formed as described by Hunter. When an ovum has been thus fecundated, and brought to maturity in the uterus, before extrusion, it is called *viviparous generation.* This is the variety which occurs in the human female.

DEVELOPMENT OF THE FŒTUS.

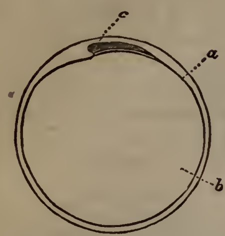
It has already been stated that, after impregnation, the ovum developes itself by its own plastic power, out of the materials supplied to it by the mother. It will be remembered that it was originally contained within the Graafian vesicle, and that it contains a yolk similar to that seen in the hen's egg, although much smaller, in the centre of which is found the germinal vesicle, on whose walls is the germinal spot or nucleus, from which all the various parts of the new being are developed. According to some physiologists, impregnation takes place in the ovary, and before the rupture of the Graafian vesicle; according to others, the Graafian vesicle is ruptured first, the ovum escapes into the Fallopian tubes and meets the male sperm on its way to the uterus. The first change which can be discovered after fecundation and consequent upon it, is the *cleavage* of the yolk, which resolves itself first into two, then into four, then into eight segments (Fig. 180, A, B, C), each segment containing a transparent vesicle, probably a descendant of the original cell germ. By a continuance of this process the whole cavity of the yolk-membrane becomes filled with a collection of cells which, from its mulberry-like appearance, is called the germinal or mulberry mass. An envelope is now formed around each of the component segments of the yolk, converting it into a vesicle, of which the contained particle is the nucleus. This happens first to the peripheral portions of the mass, which arrange themselves at the surface of the yolk into a membrane, which, becoming thicker by the addition of new cells from the interior, forms what is called the "*germinal membrane;*" and as this forms a complete sac surrounding the liquid yolk, and as

Fig. 180.

Progressive stages in the segmentation of the vitellus of the *Mammalian Ovum:* — A, its first division into two halves; B, subdivision of each half into two; C, further subdivision, producing numerous segments.

the whole structure of the future embryo originates in its substance, it has been called the *blastodermic vesicle.* On one portion of this vesicle a number of cells accumulate, constituting what is called the *area germinativa* (Fig. 181, *c*), in which all the structures of the permanent organism originate, whilst the germinal membrane itself subdivides into two layers, an inner *mucous* and an outer *serous*, between which is subsequently developed the *vascular* layer. The external layer becomes the integument; the middle, the vascular system; and the internal, the digestive apparatus.

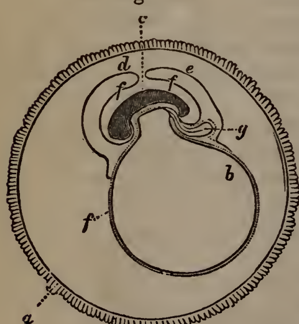
Fig. 181.



Plan of early Uterine Ovum. Within the external ring, or zona pellucida, are the blastodermic vesicle, *a*; the yolk, *b*; and the incipient embryo *c*.

The Amnion.—The outer or serous layer of the germinal membrane at the point where the embryo is developing itself, rises upon each side of it in two folds, forming the inner membrane of the ovum, which is called the amnion. These two folds gradually approach each other till actual contact takes place, in the space between the general envelope and the embryo, so as to form an additional investment to the latter. As each fold contains two layers of membrane, a double envelope is thus formed, of which the outer layer (Fig. 182, *d*, *e*) afterwards adheres to the inner surface of the chorion; whilst the inner one (Fig. 182, *f*, *f*) remains as a distinct sac, to which the name *amnion* is given.

Fig. 182.



a, chorion; *b*, umbilical vesicle, surrounded by the serous and vascular laminæ; *c*, embryo; *d*, *e*, and *f*, external and internal folds of the serous layer, forming the amnion; *g*, incipient allantois.

"The membrane thus formed embraces the embryo very closely at an early period, and is continuous with the common integument of the fœtus, at the open abdominal parietes. At a later period it is distended with fluid, and so separated from the fœtus, and after being reflected upon the funis, of which it forms the outer coat, it terminates at the umbilicus. It is thin and transparent, but of a firm texture, resisting laceration much more than the other membranes. Its extended surface is somewhat flocculent, but internally it is quite smooth, like serous membrane, and like it secretes a bland fluid." This fluid resembles dilute serum, and is called *liquor amnii.* It varies in amount from half a pint to several quarts, the average quantity being about half a pound.

It subserves several useful ends. It probably serves as a nutriment to the fœtus during the early months; it preserves an equable tempe-

rature for it while remaining in utero, it protects it from the effects of sudden blows, shocks, &c. It is also useful in dilating the os uteri, by protruding the membranes in the commencement of labour.

The *Umbilical Vesicle* is formed by the doubling in of the mucous layer under the abdomen of the fœtus, so as to enclose a cavity containing the yolk, which communicates with the digestive tract. (Figs. 180, 181, *b*.) Upon the yolk the embryo subsists as long as it lasts, the umbilical vesicle becoming smaller and smaller as it is absorbed, until finally only a narrow orifice remains, which ultimately closes up and the umbilical vesicle is thrown off; it may, however, be detected upon the umbilical cord up to a late period of pregnancy.

The Allantois.—After the yolk has been entirely absorbed, it becomes necessary that the fœtus should have some other means of support, and the following are supplied. From the inferior or caudal extremity of the fœtus there arises, at the point where the urinary bladder is afterwards seated, a delicate membranous sac, which is formed from the mucous layer, and has distributed upon its surface, a number of minute blood-vessels, from the vascular layer; this vesicle gradually extends itself between the amnion and the chorion, until it comes in contact with that portion of the uterine surface, where the villi of the chorion are most abundant; here the vessels which it carries attach themselves, in order to form the placenta, and the allantois having fulfilled its function shrivels up, although traces of it may be found in the cord. In its development the allantois passes out of the anterior part of the abdominal cavity, in the region of the umbilicus, which at this time is open. As the cavity is closing, by the gradual development of its walls towards the median line, it is separated into two portions, which communicate; that part which is within the body, forms the urinary bladder, with its urachus or tube of communication. (Fig. 183.)

Fig. 183.

Diagram representing a Human Ovum in second month; *a*, 1, smooth portion of the chorion; *a*, 2. villous portion of chorion; *k*, *k*, elongated villi, beginning to collect into placenta; *b*, yolk-sac or umbilical vesicle; *c*, embryo; *f*, amnion (inner layer); *g*, allantois; *h*, outer layer of amnion, coalescing with chorion.

The Chorion.—The outer membrane of the ovum is called the chorion, and is formed during its passage through the Fallopian tube, by receiving an additional layer of albuminous matter secreted from the walls of the tube, and this is surrounded by a fibrous membrane. This new formation is one of great importance, as it is through this the whole subsequent nutrition of the embryo is derived; this is accomplished at first by means of a number of villous processes, which proceed from the whole surface of the chorion, and give it a rough, shaggy appearance; these villous processes serve as absorbing radicles, drawing in the fluids supplied by the mother, until a more perfect communication is afforded by the placenta. As the ovum advances in age, these villi diminish in number, assume a vesicular appearance, and finally disappear altogether, except at that part of the chorion which is in contact with the uterus, and where the placenta is subsequently formed. In some animals, this connexion between the villous coat of the chorion and the uterine surface is the only one that exists, hence they are called *non-placental.*

The Placenta.—The formation of this organ commences by the penetration of the villi of the chorion into the tubuli of the decidua, already described; later we find a vascular connexion established between them and the villi, by the agency of the allantois, in the manner above mentioned; the allantois conveying the blood-vessels of the fœtus to that portion of the chorion. It must not, however, be understood, that there is any direct communication between the vessels of the fœtus and those of the mother, the fœtal tufts being merely *bathed* in the maternal blood and drawing nourishment from it by its own cells, which have the power of selecting, and of elaborating their own materials. The fœtal portion of the placenta consists of the branches of the umbilical vessels, which divide minutely where they enter the organ, and constitute by their ramifications a large portion of its substance, each subdivision terminating in a villus. Each villus contains a capillary vessel, which forms a series of loops, communicating with an artery on one side and with a vein on the other. The vessels of the villi are covered by a layer of cells enclosed in basement membrane (Fig. 184). The maternal portion may be considered as a large sac, consisting of a prolongation of the internal coat of the great uterine vessels. Against the fœtal surface of this sac the placental tufts push themselves, dipping down into it and carrying before them a portion of its thin wall, so

Fig. 184.

Extremity of a placental villus:—*a*, external membrane of the villus, continuous with the lining membrane of the vascular system of the mother; *b*, external cells of the villus, belonging to the placental decidua: *c*, *c*, germinal centres of the external cells; *d*, the space between the maternal and fœtal portions of the villus; *e*, the internal membrane of the villus, continuous with the external membrane of the chorion; *f*, the internal cells of the villus, belonging to the chorion; *g*, the loop of umbilical vessels.

as to constitute a sheath to each tuft. The blood is conveyed into the cavity of the placenta by the "*curling arteries*," so named from their tortuous course, which proceed from the arteries of the uterus; and the blood is returned through large uterine veins, called *sinuses*. The placenta performs the twofold office of an absorbing and respiratory organ; it begins to be formed about the end of the second month, acquires its peculiar character during the third, and goes on increasing in proportion to the development of the ovum. At full term its diameter is about six or eight inches, its circumference eighteen to twenty-four, and its thickness from one inch to an inch and a half. Its internal or fœtal surface is smooth and shining, being covered by the amnion; the outer, or uterine surface, is level but not so smooth, being divided by numerous sulci between the lobules of which it is composed.

The umbilical cord, called also the *funis*, or *navel-string*, is the means of communication between the fœtus and placenta. It usually arises from the centre of the placenta, though sometimes from the edge, forming the *battledore-placenta*. It consists of two umbilical arteries, and one umbilical vein; besides these it contains the duct of the umbilical vesicle, the omphalo-mesenteric vessels, the urachus, and sometimes more or less of the intestinal canal, the whole imbedded in the Whartonian jelly, and invested by a reflection from the amnion. The length varies much; the average, however, is about eighteen inches. Sometimes it is so short as seriously to impede the progress of the labour.

To return now to the development of the embryo, the account of which is condensed from the Elements of Physiology, by Dr. Carpenter.

The parts first formed are those which most clearly distinguish the vertebrated animals from all others, viz., the vertebral column and spinal cord. These first make their appearance in the situation of the cluster of cells known as the *area germinativa*, and are included under the name of *chorda dorsalis*, which is found to be composed, wherever it exists, of nucleated cells. From cells exterior to this, is developed the vertebral column. Concurrently with this development, appears the vascular system, which is first seen in the middle layer of the germinal membrane, called the *vascular*. Vessels are formed here which serve to take up the nutriment supplied by the yolk, and carry it to the tissues of the embryo. These vessels are first seen in that part of the vascular lamina of the germinal membrane which immediately surrounds the embryo, and they form a delicate network of vessels called the *vascular area*; this gradually extends itself till the vessels spread over the whole of the germinal membrane, and it is through their agency that the nutritious matter of the yolk is conveyed to the embryo. The vessels of the yolk-bag terminate in two large trunks, called omphalo-mesenteric, meseraic, or vitelline vessels, which enter the embryo at the point which afterwards is known as the umbilicus. The first movement of fluid takes place *towards* the em-

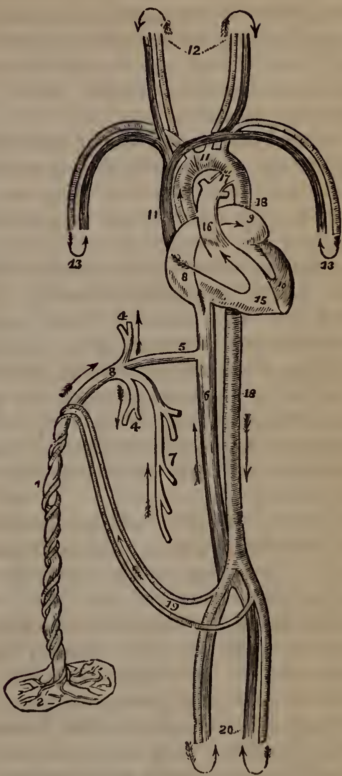
bryo, and may be discovered before any heart is seen. The heart is formed in the substance of the vascular layer, by a dilatation of the trunk, into which the blood-vessels unite. It is at first a mere excavation, but afterwards its walls become more developed, and it is divided into cavities. Along with the development of the vascular apparatus, appears also the permanent digestive cavity; this originates in the separation of a small portion of the yolk-bag lying immediately beneath the embryo, by a doubling in of the mucous layer, so as to enclose a cavity. This, by subsequent prolongation and involution of its walls, is rendered more complex, so as to form a stomach and intestinal tube. The digestive cavity communicates for some time with the yolk-bag (from which it has thus been pinched off) by the opening that is left by the imperfect meeting of the folds of the germinal membrane that forms its walls. In the mammalia, this orifice is gradually narrowed, and at last completely closed; and the yolk-bag thus separated is afterwards thrown off; it is then known as the *umbilical vesicle*, and may be seen upon the umbilical cord up to a late period of pregnancy.

At first the body of the embryo is more elongated than afterwards, and the trunk is the first part developed, at the upper extremity of which is a small prominence less thick than the rest, and separated by an indentation, which distinguishes the head. No traces of extremities can yet be discovered, or of any other prominent parts. It is straight, or nearly so, the posterior part being slightly convex, the anterior concave.

Afterwards the head becomes more rapidly developed, so that at the beginning of the second month, it nearly equals the half of the whole body. In the fifth week, the extremities become visible, the upper generally appearing first, in the form of small blunt prominences. As they develope themselves, the distant points appear first, that is, first the hands, which seem to be fixed to the shoulders, then the fore-arm, then the arm. The same is true of the lower extremities. The external organs of generation appear after the development of the extremities, as also do the nose, ears, and mouth. Ossification commences in the base of the cranium, and the bones under the scalp are those in which the process is last completed. The length of a full-grown fœtus is about eighteen inches, the weight between six and eight pounds as the average.

Fœtal circulation.—The peculiarities of the fœtal circulation, in which it differs from that function in the adult are, 1st. The *ductus venosus*, a supplementary vein, situated at the thick edge of the liver, and leading from the umbilical vein to the vena cava ascendens. 2d. The aperture between the right and left auricle, effecting a communication between them, called the *foramen ovale*. 3d. The *ductus arteriosus*, a branch given off from the pulmonary artery soon after its origin, which conducts the venous blood that has arrived at the heart from the head into the aorta just below its arch.

Fig. 185.



The fœtal circulation: 1. the umbilical cord, consisting of the umbilical vein and two umbilical arteries; proceeding from the placenta (2); 3, the umbilical vein dividing into three branches; two (4, 4) to be distributed to the liver; and one (5) the ductus venosus, which enters the inferior vena cava (6); 7, the portal vein, returning the blood from the intestines, and uniting with the right hepatic branch; 8, the right auricle; the course of the blood is denoted by the arrow, proceeding from 8 to 9, the left auricle; 10, the left ventricle, the blood following the arrow to the arch of the aorta (11), to be distributed through the branches given off by the arch to the head and upper extremities. The arrows, 12, and 13, represent the return of the blood from the head and upper extremities through the jugular and subclavian veins, to the superior vena cava (14), to the right auricle (8), and in the course of the arrow through the right ventricle (15), to the pulmonary artery (16); 17, the ductus arteriosus, which appears to be a proper continuation of the pulmonary artery—the offsets at each side are the right and left pulmonary artery cut off; these are of extremely small size as compared with the ductus arteriosus. The ductus arteriosus joins the descending aorta (18, 18), which divides into the common iliacs, and these into the internal iliacs, which become the umbilical arteries (19), and return the blood along the umbilical cord to the placenta; while the other divisions, the external iliacs (20), are continued into the lower extremities. The arrows at the termination of these vessels mark the return of the venous blood by the veins to the inferior cava.

The following is the route of the circulation in the fœtus, starting from the placenta. The blood, after being aerated in this organ, is collected by the *umbilical vein*, which carries it to the umbilicus of the child. After entering the cavity of the abdomen, the current divides, part of it being sent through the venæ portarum to the liver; the remainder reaches the vena cava ascendens through the *ductus venosus*, where it is mixed with the blood from the inferior extremities. The blood that was sent to the liver is collected by the hepatic veins and also emptied into the *vena cava* ascendens, which finally discharges its contents into the right auricle of the heart. From the *right* auricle, it is directed by the Eustachian valve through the *foramen ovale*, into the *left* auricle, thence it passes into the left ventricle, by which it is distributed through the aorta to the system, a large proportion of it going to the head and upper extremities. The latter blood (that from the head, &c.), is collected by the vena cava descendens, and emptied

also into the *right* auricle, from whence it passes into the *right ventricle*, from thence mainly through the *ductus arteriosus* into the aorta, a small portion only passing into the pulmonary artery. From this it will be seen that the liver is the only organ that receives the blood from the placenta *unmixed*. Every other organ receiving mixed arterial and venous.

After birth, the current is entirely changed by the establishment of respiration, and its diversion into the lungs. The ductus venosus and the ductus arteriosus shrivel up into ligamentous cords; the foramen ovale shortly closes by the apposition of its valve; the pulmonary artery and vein become dilated to receive the increased current, and the circulation, which before resembled that of the higher reptiles, becomes now that of the perfect mammal. It not unfrequently happens, however, that some arrest of development takes place, and prevents the completion of these changes; various malformations hence result, involving an imperfect discharge of the function.

It will be borne in mind by the student, that there is, in the fœtal circulation, a deviation from the normal function in several of the vessels. The umbilical vein and ductus venosus carry *arterial* blood; while the umbilical arteries and ductus arteriosus carry *venous* blood (Fig. 185).

Duration of Pregnancy.—On this subject very little can be positively said, the *average* duration being about ten lunar months, or 280 days. There can be no doubt that many females fall short of this computation, as well as that there are many who go beyond it. Many well-authenticated instances are on record, under the authority of Drs. Merriman, Blundell, Montgomery, Dewees, Meigs, and others, where both these deviations have occurred. The same is true of the lower animals. Dr. Rigby supposes that the duration of pregnancy is much influenced by the time in the intermenstrual period at which conception took place; that there is at every menstrual period an irritability about the uterus, even when gravid, which disposes it to take on contraction. Hence, when impregnation has occurred immediately after an appearance of the menses, the uterus will have attained such a dilatation and weight of contents by the time that the ninth period has arrived, that it will not be able to pass through this state of catamenial excitement without contracting, or in other words, labour coming on: hence it is that we find a considerable number of labours fall short of the usual time, so much so, that some authors have even considered the natural term of human gestation to be 273 days, or 39 weeks.

If, on the other hand, impregnation has occurred just before a menstrual period, the uterus may not have attained such a development as to prevent its passing the ninth period without expelling its contents, but may even go on to the next without this process taking place. Under this view of the subject, he further remarks, "the duration of time between each menstrual period should also be taken into account, some women menstruating at very short, others at very long intervals;

but although this will affect the number of periods during which the pregnancy will last, it will not influence the actual duration of time, as this will more immediately depend upon the size and weight of contents which the uterus has attained."

The method of calculation is, to compute from a fortnight after the last appearance of the menses, and the period so fixed is usually corrected by the time at which quickening occurs, the latter occurrence usually taking place at four months and a half.

DIGESTION.

The first of the nutritive functions may be defined as that by which the *food or aliment is "reduced to such a condition that the nutritive material can be separated from it."* In animals, the food being for the most part in a solid form, requires to be brought to a fluid state before it can be inservient to nutrition, hence the necessity for a digestive process.

In the animal body, aliment is demanded for four different purposes. *First*, for the original construction or building up of the organism. *Second*, to supply the loss occasioned by the continual decay, even when in repose. *Third*, to compensate for the waste occasioned by the active exercise of the nervous and muscular system. *Fourth*, to supply the materials for the heat-producing process, by which the temperature of the body is kept up.

The amount required for these several purposes, varies according to the condition of the body as regards exercise or repose, external heat and cold, and the age of the individual, a larger quantity being demanded in youth in proportion to the size of the body, than in manhood. Any drain upon the system also increases the demand.

There can be no universal law laid down as to the amount required, so much depending upon the external conditions in which the individual may be placed. The diet scale in the British navy allows to each man from 31 to 35½ ounces of dry nutritious matter daily: of this 26 oz. are vegetable, and the rest animal, 9 oz. of salt meat, or 4½ of fresh meat, being the allowance of the latter. A mixed diet seems to be absolutely indispensable, where such a variety of tissues have to be repaired. The disastrous effects resulting from the long-continued use of one kind of food, are to be attributed not so much to the quality or quantity, as to the absence of variety in the aliment supplied.

Aliments have been variously classified; Prout divides them into the following groups. *Aqueous*, including water, either alone, or holding important elements in suspension or solution. *Saccharine*, including sugars, starch, gums, and vinegar. *Oily* or *oleaginous*, including the various fats, oil, and alcohol. *Albuminous*, including all those substances which contain nitrogen—such as fibrine, gelatine, albumen, caseine, and vegetable gluten. All the materials which make up this

group are derived generally from the animal kingdom, with the exception of the last, which is contained in great abundance in wheat. Similar, if not identical principles exist in vegetables.

In milk we find a natural combination of all the various substances which contain nitrogen, and this is the only instance in which nature has provided a single article of food for the support of the animal body in which such a union exists.

Liebig divides aliments into two classes. *Azotised*, and *non-azotised*. The azotised products are for the nutrition and reparation of the animal tissues, hence he calls them "*plastic elements of nutrition.*" The non-azotised substances are designed chiefly, according to him, to supply the materials for animal heat and respiration, hence he calls them "*elements of respiration.*" The unconsumed material being deposited as fat.

Dr. R. D. Thomson proposes to call the azotised, *nutritive elements*, and the non-nitrogenised, *calorifacient.*

The organic compounds enumerated would be of little service without the admixture of certain inorganic substances, which also form a part of the animal frame, and which are constantly being voided by the excretions. These are *chloride of sodium*, which enters into the composition of the gastric juice, and the bile; *phosphorus*, which is found in the osseous and nervous tissues; *sulphur*, found in the albuminous tissues; *lime*, which is required for the consolidation of bone; and lastly, *iron*, which will hereafter be shown to be an essential constituent of hematosine.

The digestive apparatus varies greatly with the habits of the animal, and with the nature of the aliment with which it is supplied; thus in *carnivorous* animals it is exceedingly simple, because the food requires to undergo little change before it is fitted for nutrition. In the *ruminantia* the food is macerated in a complex stomach, prior to, as well as after it has been subjected to a more complete mastication than is employed in other animals, because the aliment contains but little nutritive matter, which is with difficulty separated from it. In the *omnivorous* animal the digestive apparatus is midway between those above described.

Modifications also occur in the masticatory process; the vegetable-feeder requiring a more complicated dental apparatus; the carnivora being provided with teeth of a simpler construction, but more fitted for seizing and tearing their prey. In the omnivorous animal we find both the cutting and grinding teeth. In birds there are no teeth; and mastication, properly so called, is effected in the stomach, a portion of which (the gizzard) acquires a great increase of the muscular power, and is lined by a dense cuticle, and thus becomes a powerful organ for triturating the food, the bird swallowing pieces of flint or other hard substances to aid in the mechanical reduction.

Hunger and Thirst.—The want of solid aliment is indicated by

the sensation of *hunger;* and that of liquid by *thirst.* The former of these sensations is referred to the stomach, and the latter to the fauces; but, although these sensations may be caused by the condition of the parts mentioned, they are really indicative of the wants of the system at large.

The nerve which is instrumental in the sensation is probably the *vagus* by its gastric branches, but there is no reason for denying to the sympathetic nerve distributed to the stomach, some share in this phenomenon; the latter probably conveys the wants of the system to the stomach, while the former is the medium by which those wants are expressed. Section of the vagus abates, if it does not entirely arrest the sensation of hunger. The same is true of the introduction of matters not alimentary into the cavity of the organ.

Thirst results from a peculiar state of the mucous membrane of the digestive tube, but more especially of the mucous membrane of the mouth and fauces, caused by the imperfect supply of liquid. Thirst is perhaps more immediately connected with the wants of the general system than hunger, since the relief that is afforded by the introduction of liquid into the stomach is immediate, and may be fully accounted for by the instantaneous absorption of the fluid into the veins. Any excess in the amount of fluid excretions will increase this sensation, as is also the case when stimulating or irritating articles of food have been used; the purpose of this increase is obviously to cause ingestion of fluid, by which they may be diluted.

The process of digestion may be divided into the following stages: 1st. *Prehension of food;* 2d. *Mastication and insalivation;* 3d. *Deglutition;* 4th. *Chymification;* 5th. *Action of small intestine;* 6th. *Defecation.*

Prehension, or the taking of food into the mouth, is performed mainly by the hand, assisted by the lips and cheeks, as well as the anterior teeth and the tongue.

Mastication has for its object the comminution of the food, so that it can be readily acted upon by the solvent juices of the stomach. The contact of the solid food with the interior of the mouth excites the act of mastication, performed by alternating contractions of the muscles which pull the lower jaw upward, downward, backward, forward, and laterally by acting on the bone on which they are implanted. By the motion of the lower teeth upon the upper the food is comminuted. During mastication the food is mixed with the saliva and fluids of the mouth, which latter cavity is closed anteriorly and posteriorly during the process.

The disintegration of the food by mechanical reduction, is manifestly aided by *insalivation.* The admixture of the saliva, however, has principally a mechanical effect, the nature of the secretion being different and answering different purposes. That of the parotid and submaxillary glands is thin and limpid, and assists mastication; that of the sublingual is thick and glutinous, and assists deglutition.

Their effects upon the elements of food cannot be judged of by their reaction out of the body, since it has been shown by M. Bernard, that in order to convert starch into sugar the saliva must have undergone incipient decomposition, and must be alkaline, conditions which cannot obtain when the food is rapidly passed into the stomach. The saliva, therefore, has probably no other effect than that of softening the food; from the admixture of its watery particles. It is hardly necessary to say that the drier the food, the greater will be the amount secreted.

Deglutition. — The food, comminuted and moistened in the mouth by the means above mentioned, is prepared for the action of deglutition. In this there are *three* stages. In the *first*, the particles of the food, collected to a bolus, glide between the surface of the tongue and the palatine arch, till they have passed the anterior arch of the fauces. This is a purely voluntary movement. In the *second*, the bolus is carried past the constrictors of the pharynx. In the *third*, it reaches the stomach through the œsophagus. These three acts follow each other with extreme rapidity.

During the *second* stage of deglutition, the tongue, the muscles of the anterior and posterior half arches, the superior muscles of the soft palate, and the constrictors of the pharynx, are all in action. In this stage, by the retraction of the tongue, and the elevation of the larynx, the epiglottis is pressed over the rima glottidis, which is also closed during this process.

The communication between the fauces and posterior nares is cut off by the muscles of the posterior palatine arches, which contract in such a manner, as to cause the sides of the arch to approach each other like a pair of curtains, and to the cleft between the two sides, the uvula is applied like a valve. Some of these acts may be performed voluntarily, but the combination of the whole is automatic, and under the presidency of the *reflex system* of *nerves.*

In the *third* act, in which the food passes through the œsophagus, every part of that tube, as it receives the bolus and is dilated by it, is stimulated to contract.

The movements of the œsophagus are entirely involuntary and rhythmical in their character; in the act of vomiting they are inverted. At the point where the œsophagus enters the stomach,—the cardiac orifice of the latter,—there is a sort of sphincter. This opens when there is sufficient pressure made upon it by the accumulated food, and afterwards closes so as to retain the food in the stomach. The opening of the cardiac orifice is one of the first acts in vomiting. When the sphincter is paralysed by division of the pneumogastric nerve, the food regurgitates into the œsophagus.

Chymification.—As soon as the bolus has entered the stomach it is subjected to several agencies, all of which are more or less concerned in effecting its solution. It is exposed in the first place, to the movements of the stomach, which have for their object to produce the thorough intermixture of the gastric juice with the alimentary mass.

The fibres of the muscular coat of the stomach are so arranged, as to shorten its diameter in every direction; by the alternate contraction and relaxation of these bands, a great variety of motion is induced. This contraction is due to the stimulus of the food; and when the aliment is difficult of digestion, the muscular coat is proportionately stimulated. These movements are also increased by the action of the respiratory muscles. The contraction of the muscular fibres extends also to those of the two orifices of the stomach so as to prevent the escape of the food. This is particularly the case as regards the pyloric orifice in the first period of digestion.

The bolus, in the next place, is exposed to the action of the *gastric juice*, a pure, colourless, and slightly viscid fluid, having a distinctly acid reaction, which has been observed to distil from the surface of the mucous membrane and mingle with the food. The exudation of this fluid is *always* excited by the contact of any foreign substance, but it is never present in the organ when empty, the sole contents being then a little viscid mucus. According to the analysis of Professor Dunglison, the gastric juice contains free muriatic and acetic acids, phosphates and muriates of potassa, soda, magnesia, and lime. According to the experiments of Blondlot, its acid reaction is due to the presence of the super-phosphate of lime, while Professor Thomson and MM. Bernard and Barreswil attribute it to the presence of lactic acid, the existence of which in the healthy stomach has been positively denied by Liebig.

The gastric juice is secreted through cell agency, by follicles of a tubular shape, resting upon the sub-mucous tissue, having their open ends towards the cavity of the stomach.

But diluted acids, of themselves, have no power in chymifying alimentary substances, although their presence in the gastric fluid is essential to its action. The active agent is an organic compound obtained from the mucous membrane of the stomach, to which the name of *pepsine* or *gasterase* has been given. It is a proteine-compound in a state of change, and it seems to act in precisely the same manner as the diastase does in the conversion of starch into sugar. In so doing, it acts as a sort of *ferment*, having the power of exciting change in another substance, in which it does not itself participate. Pepsine undergoes no change itself, and forms no combinations with the substances on which it acts, but merely disposes them to solution in the acids of the stomach, with which they form definite chemical compounds.

The quantity of gastric juice prepared, is regulated by the *wants of the system*, and not by the amount of food taken; hence all that is taken over and above these wants will act as a source of irritation. Bidder and Schmidt estimate the quantity secreted daily at seventeen pounds, and Dr. Dalton has calculated that sixteen pints are required to dissolve one pound of meat.

All substances are not equally soluble in the juices of the stomach;

in general terms it may be said, that animal food is more soluble than vegetable, though there are exceptions to this rule. Of the *saccharine group*, sugar is generally converted into *lactic acid* during its passage along the intestinal tube, and is probably absorbed in this form, unless it have been administered for a long time. The particles of starch, when their envelopes have been ruptured, are converted into *dextrine* and *grape sugar;* which change, however, takes place most largely in the intestinal canal under the influence of its secretion. It is now certain that the substances of this class may be converted into oleaginous compounds, though the mode and situation in which this change occurs is not positively known; probably it is by the action of the bile, the long-continued contact of which with saccharine matter occasions the conversion of part of it into an adipose compound.

The substances of the *oleaginous* class do not undergo much change in the stomach, except a minute subdivision of their particles in the form of an emulsion. When the pancreatic secretion is mixed with them they form an emulsion which is more readily absorbed by the chyliferous vessels.

The *proteinaceous* compounds, whether derived from animal or vegetable food, are all reduced to a state of solution, if the gastric digestion have been properly performed; and in this state they have all the properties of albumen. Gelatine will be dissolved, or not, according to its condition; if ingested in a state of solution it remains so; if previously prepared for solution by boiling, its solution is completed; but if it exist in a tissue from which it cannot be readily extracted, it will pass out almost unchanged.

Lastly, the bolus is exposed to the *temperature* of the stomach, which is about 100° Fahr. It was found by the experiments of Dr. Beaumont that the gastric juice had very little effect in dissolving alimentary matters, when the temperature was below this. Hence the taking of cold drinks during digestion is extremely prejudicial to this act.

The fluids taken into the stomach are for the most part absorbed from it, and do not even pass the pylorus. The solids, with the exception of the insoluble parts, are reduced to a substance called *chyme*, the consistence of which will of course vary with the amount of fluids taken. In general it is grayish, semifluid, and homogeneous, with a slightly acid taste and smell. When the fluid has been of a rich character it resembles cream; when of a farinaceous order it resembles thin gruel.

The time occupied in the reduction varies, according to the nature of the food, from three to five hours; and it is now generally conceded that this reduction is a true *chemical solution*, and not a process of *putrefaction*, *trituration*, or *fermentation*.

The *gas* contained in the stomach during digestion is generally very small in quantity. Magendie and Chevreul obtained some from the

stomach of an executed criminal, and found it to consist of Oxygen, 11·03, Carbonic acid, 14·00, Hydrogen, 3·55, Nitrogen, 71·45.

Action of the Small Intestine.—The passage of the chyme through the pyloric orifice is at first slow; but when the digestive process is nearly completed, it is transmitted in larger quantities. The movements by which this passage is effected are of a peristaltic character, each one being preceded by a series of slighter movements in the opposite direction. The chyme is mingled in the duodenum with the biliary and pancreatic secretions, which effect an immediate alteration in its sensible and chemical properties. "Mr. Bernard has shown, that when this fluid is put in contact with fatty substances of every nature, as oils, animal fats, butter, &c., they are quickly digested or decomposed, and reduced to a state in which they may be absorbed into the circulation. This property is peculiar to the pancreatic juice, not being possessed by the saliva, gastric juice, bile, serum, nor by any other fluid of the animal economy.

"The first effect produced when the pancreatic fluid is put in contact with oil, or any fatty substance, is to form an immediate emulsion, which will not separate on standing.

"If oil is agitated with saliva, gastric juice, serum or pure bile, or any other animal fluid, the mixture separates when in repose. (Bile of animals, mixes, or makes an emulsion with grease, by virtue of the pancreatic fluid, that is frequently mixed with it.) After the emulsion is produced, the oil is decomposed into *glycerine* and a *fatty acid*, as the oleic acid, &c., which are absorbable as well as the simple emulsion.

"M. Bernard has also established another very important fact, in regard to the digestive fluids,—which is, that the union of the bile and pancreatic fluid produces a new and distinct fluid, having in addition to the peculiar properties of these fluids, another superadded, viz.: that of digesting azotized substances, or in other words the properties of the gastric juice, thus securing the proper digestion of the food that may have escaped the stomach.

"The property that the pancreatic juice possesses, of transforming starch into sugar, and which until now has been considered its chief property, is a very subordinate one and by no means peculiar, as almost all the other fluids of the economy possess it, viz., the saliva, serum of the blood, liquor of cysts, &c." When the bile and pancreatic secretions are mixed with chyme out of the body, as was done by Dr. Beaumont, the chyme is separated into three parts;—a reddish-brown sediment,—a whey-coloured fluid in the centre,—and a creamy pellicle on the top. The central portion, and the creamy pellicle, seem to constitute the materials from which the chyle is elaborated, the creamy matter consisting of the oleaginous particles, and the whey-like fluid containing proteine-compounds, saccharine, and saline matters in solution; while the sediment, consisting of the in-

soluble matter of the food and of biliary matter, is probably excrementitious.

The contents of the alimentary canal become more consistent, and obtain more of the fæcal character, as they pass down the intestinal tube; during which time there is also mixed with them the secretions of the various follicles: of Brunner, in the duodenum; Lieberkuhn, in the whole route; and Peyer, at the termination of the ileum. The last have no excretory orifice, but discharge their secretion by cell agency. In the neighbourhood of these glands the fæcal matter obtains its characteristic odour, probably from their secretion, which is depuratory.

The movements of the intestinal canal are dependent upon the contraction of its muscular coat, and are directly excited by the contact, either of the fæcal matter, or of the secretions poured into it. This movement is called the *peristaltic action* of the bowels. It is not dependent on nervous influence, as is seen from the fact, that it will continue after all nervous communication has been cut off. The influence of the emotions upon this movement is probably due to the sympathetic nerve, which is distributed to the whole intestinal tract.

Defecation.—The large intestines act as a reservoir and excretory canal for the fæces. And as the passage through them is not so rapid as in the small intestine, the fæcal matter accumulates until the desire to expel it arises. The contractions of the muscular coat of the large intestines are wholly without the domain of the will; but the involuntary escape of the fæces is prevented by the action of the sphincter ani muscle, which is partly under the influence of the reflex system of nerves. The concurrence of voluntary muscles with the action of the intestines, is necessary to overcome the contraction of the sphincter. The act is finally accomplished, principally by a contraction of the diaphragm and abdominal muscles upon a full and sustained inspiration, the glottis being closed so as to prevent the escape of the air contained in the lungs.

ABSORPTION.

Absorption is that function, by which nutritive, or other matters, are taken up and carried into the circulation. There are two great divisions of this function: 1st. *External absorption*, or *the absorption of composition*, which obtains from without the organs the materials intended for their construction. 2d. *Internal absorption*, or, the *absorption* of *decomposition*, which takes up from the organs the old, or effete matter that has to be replaced by new.

By *external absorption* is meant that which takes place from the external surface of the body, including the skin, and the mucous membranes of the digestive and respiratory passages. By *internal*, or *interstitial absorption*, is meant that which takes place from the component tissues of the organs themselves, and from the interior of shut sacs.

The great agents of external absorption are the veins and chyliferous vessels; of internal absorption, the lymphatics. In the chyliferous and lymphatic vessels the fluid is always found to possess the same general properties.

The veins exert no selecting power, but receive into their interior by imbibition, any fluid that possesses the proper degree of tenuity, which is then carried along with the current of the circulation. Thin fluids when taken into the stomach, in this manner enter the circulation. When the extraordinary vascularity of the whole gastro-intestinal membrane is considered, together with the peculiarity of the special distribution of the capillaries in the villi; and when it is remembered also that the rapid movement of blood through these, creates the condition most especially favourable to the passage of liquids into them from the outside, it might be almost certainly affirmed that endosmose must take place between the contents of the alimentary canal and the blood in the vessels. This conclusion has been confirmed by numerous experiments, so that we can now understand that solutions of albumen, gelatine, or sugar, may pass into the blood-vessels by endosmose, when the relative densities of the two fluids on the two sides of the intestinal membrane are such as to favour the inward current. So also if the exterior liquid be such as to favour exosmose, some of the constituents of the blood may be drawn into the intestinal canal, as is seen in the case of purgative salts, already referred to (page 249). Matters which find their way from the stomach or intestines into the circulation, by permeating the coats of the capillaries, do not pass directly from the intestinal veins into the vena cava; they circulate through the liver before reaching the general circulation. Magendie has observed, that in their transit through the liver the properties of many substances are altered; at all events they become so thoroughly mixed with the blood in their route through the portal system, that their possibly injurious influence upon the centre of the circulation is, in a great measure, obviated. Substances that require digestion on the other hand, must pass through the chyliferous vessels and thoracic duct before being mixed with the blood.

Alimentary, or *digestive absorption*, which is included under the head of *external* absorption, takes place in the small intestines, and is exercised upon the food after it has been subjected to the digestive process. The vessels that are concerned in it are the *lacteals*, or absorbents of the intestinal walls. These are engaged almost exclusively in the absorption of *nutritious materials;* other articles finding their way into the circulation through the veins. The lacteals commence in the *villi* of the mucous lining of the intestinal tube, below the point where the ductus communis choledochus and pancreatic duct open into the duodenum. Each lacteal tube commences in a single villus, by a *closed extremity*, and the trunk that issues from each villus is formed by the confluence of several smaller branches, which anas-

tomose freely with each other, forming *loops*, so that there is no proper free extremity in any case, nor do the lacteals *ever commence by open orifices upon the surface of the intestinal canal.* (Fig. 186.)

Fig. 186.

The *lacteals* appear to receive substances of a particular class, more especially fatty matters in a state of more or less fine division, with which albuminous compounds are intimately mixed. These, whether received at once into the lacteals by the instrumentality of cells at the extremity of the villi, or first imbibed by the blood-vessels and then transferred to the latter, are doubtless obtained directly from the food, as the chyle varies somewhat with the quality of the food taken, being an opaque white if the food were fatty, and more transparent if that article were absent. On the whole it seems probable, from the experiments of Bernard, Matteucci, and others, that the function of the lacteals is to take up the oily particles of food, and to bring them into that intimate relation with albumen which seems to be essential for their subsequent assimilation. Still, there is reason for the belief that the blood-vessels also may be concerned in the absorption of oily matters by endosmose, since Matteucci has shown that oily emulsions will pass by endosmose through an animal membrane, to an alkaline solution on the other side, precisely the condition of things that occurs when fatty matters have been reduced to a state of fine division in the alimentary canal and rendered alkaline by admixture with the bile and pancreatic fluid; they can then pass through the animal membrane to mingle with the blood, which is also slightly alkaline.

The fluid that is found in the lacteals is called *chyle*, and the chyliferous vessels seem to have the power of *selecting* the particles of which the chyle is composed, while they reject any other ingredients which may be contained in the fluid of the intestines, as is seen when substances easily detected, are mingled with the blood: they are readily discovered in the blood or urine, but not in the chyle.

The milky colour of the chyle is owing to the presence of minute particles described as the *molecular base of the chyle.* It also contains fat, albumen, fibrine, and salts in varying quantities.

The course of the chyle, after leaving the intestinal canal, is through the chyliferous vessels and ganglia of the mesentery, into the receptaculum chyli or commencement of the thoracic duct, along which it passes to enter the circulation at the point where the left internal jugular and subclavian veins unite. During this passage it undergoes several marked changes in its physical and vital properties. When it first leaves the intestine its principal constituent is *fat;* if examined in the lacteal vessels of the mesentery, at a point between the mesenteric ganglia and the receptaculum chyli, the fat will be found to have

diminished in quantity, while *albumen* will be in maximum quantity and *fibrine* in medium quantity; and a slight coagulability will also be manifested. The chyle taken from the thoracic duct contains little or no fat, a medium quantity of albumen, and a maximum quantity of fibrine, and is now distinctly coagulable, and has a slight rosy tint. These circumstances have given rise to the belief that the chyle, as it proceeds, becomes more and more animalised, or transformed into the nature of the being to be nourished. MM. Tiedemann and Gmelin infer that it is to the action of the mesenteric glands, that the chyle owes these important changes in its nature; — the fluid in its passage through them, obtaining from the blood circulating in them, the new elements which animalise it.

The *chyle corpuscles* are supposed by Dr. Carpenter to originate in the mesenteric ganglia, and to be the altered epithelium-cells which line the lacteals in their course through these bodies. Their ultimate destination is to be converted into blood corpuscles.

Internal, or *interstitial absorption*, is effected by agents strongly resembling those concerned in the absorption of chyle. One part of the apparatus, the thoracic duct, is common to both. The lymphatics are distributed through the greater part of the body, especially upon the skin. They have never been found to commence by closed or open extremities; but seem to form a network from which the trunks arise. In their course they pass through glands called lymphatic glands, which exactly resemble in structure and function those of the mesentery. The same processes are probably concerned in the elaboration of the *lymph*, as of the *chyle*, and the fluid thus formed is likewise a nutritive fluid, differing from the chyle, however, chiefly in the absence of fat. It is mingled with the chyle in the thoracic duct. So that what is true of *chylosis*, is also true of *lymphosis*, both forming a part of the nutritive operations.

The lymphatics, however, sometimes take up materials that are not inservient to nutrition, as bile, pus, the venereal and other virus that may be brought in contact with them. But these facts merely prove that the walls of the lymphatics are permeable by such substances, for thin fluids will always enter those vessels that present the thinnest walls and the greatest surface. As this is the case with the lymphatics upon the surface of the body, it explains the phenomena of absorption through that surface. In the lungs and in the intestinal canal, the veins are most numerous, hence these are the recipients of the thin fluids. In both cases the fluids soak in by imbibition. In the case of the absorption of pus, the probability is that the absorbents must have been laid open themselves by the ulcerative process, since the pus-globule is too large to have gained admittance in any other way.

It is difficult to speak with certainty of the *source* of the matters absorbed by the lymphatics. Their contents bear a close resemblance to the fluid element of the blood, or "liquor sanguinis" in a state of dilution. Dr. Carpenter supposes them to consist of the residual fluid,

which having escaped from the blood-vessels into the tissues for their nutrition, is now to be returned to the former. They may also include those particles of the solid framework which have lost their vital powers, and are therefore not fit to be retained as components of the living system, but are not yet so far decayed as to prevent their serving as materials for reconstruction after being again subjected to the organizing process.

The same author says further, that if this view of the function of the lymphatics be correct, it follows that we must attribute to the blood-vessels the absorption of truly effete particles; and in this there would seem to be no improbability, since we know that the venous blood contains the elements of two important excretions, that of the liver and that of the lungs, in far greater proportion than arterial blood; and there is also in the former fluid a certain amount of "ill-defined animal principles" that seem ready to be thus thrown off.

The lymph very closely resembles the chyle, the main difference being in their colour, the lymph being nearly colourless. Both contain the same ingredients, but not in the same proportions, the chyle abounding most in organic elements. Both contain peculiar corpuscles, and are capable of self-coagulation; in fact, each may be looked upon as imperfectly-elaborated blood.

The movements of the chyle and lymph in their respective vessels are due partly to *vis à tergo*, but mainly to the contractility of the middle coat. Both sets of vessels are supplied with valves, which prevent a retrograde movement.

The absorption that takes place through the skin, or *accidental absorption*, as it is called, is effected by the agency of the lymphatics also, which are here very abundantly distributed. In this case there is no selection, the fluids passing in by simple imbibition. In the pulmonary mucous membrane, as in the digestive, thin fluids are taken up by the veins. In general, wherever a thin fluid is placed in contact with an extended surface, it will be taken up by those vessels that present the largest surface and the thinnest walls. The rapidity of this absorption through the skin and mucous membrane, is greatly influenced by the condition of the blood-vessels; being very great when the vessels are drained of their contents, and proportionately small when they are full. The presence or absence of the epidermis affects it, as might be readily inferred. The external integument, so long as it is covered with the epidermis, absorbs with extreme slowness; the epidermis removed, however,—by means of a blister,—and the vascular lamina of the corium exposed, absorption goes on with extreme rapidity. It is upon this fact that what is called the *endermic* method of exhibiting medicines depends.

In regard to the absorption of fluids from serous cavities, it is remarked, that imbibition does not explain all the phenomena; the probability is that the lymphatics under certain circumstances are also concerned. If the fluid in the veins be more concentrated than those

to be absorbed, then imbibition is sufficient. But if, on the contrary, the external fluid is equally concentrated with that contained in the interior of the vessels, the two fluids ought to pass through the membrane in both directions with equal rapidity. And if the fluid in the vessels be less concentrated of the two, it will exude in greater quantity, so as to increase the amount of the effused fluid. A collection of fluids in the pleura or peritoneum, containing albumen and salts in the same state of concentration as those substances exist in the blood, would not be diminished in quantity by imbibition alone; there would be merely an interchange of the saline matters contained in the external fluid and in the blood, while the bulk of the former would remain the same. The probability is, therefore, that in this case there would be other agents than the blood-vessels concerned in the absorption, viz.: the lymphatics. It is possible that the process of endosmosis may be modified by a peculiar attraction exerted by the tissues on the fluids circulating in them; an attraction, by the agency of which the fluids in the tissues may be retained while the external fluid is absorbed, so that merely absorption, and not an interchange of fluids, as is the case under ordinary circumstances, is the result.

RESPIRATION.

RESPIRATION is that function by which venous blood is converted into arterial; carbonic acid, given off from, and oxygen taken into the system. In the higher classes of animals the whole of the circulating fluid is sent through special organs, formed on the same general principle as the secreting glands, which fulfil incessantly an office the most essential to life; these organs are the lungs. In the lungs, the mass of the circulating fluid, which had been changed in the periphery of the body into venous blood, mixed with the lymph from all parts, and the newly-elaborated chyle, is brought into intimate contact with the air of the atmosphere, the effect of which is to restore to the blood its bright colour, and to give to it the arterial character, which is alone competent to minister to nutrition, and to impart to the nervous system and locomotive apparatus their proper stimulus. The arterial blood, thus changed, also supplies to the secretory apparatus the material for the exercise of its function. All that is necessary then for these purposes is, that the blood should be exposed to the influence of the atmospheric air, or air dissolved in water, through the medium of a membrane that shall permit the diffusion of gases; an interchange then takes place between the gaseous matters on the two sides,—carbonic acid being exhaled from the blood and replaced by oxygen.

The extrication of carbonic acid is effected in a manner that renders it subservient to the introduction of oxygen, which is required for all the most active manifestations of vital power; and it is in these two actions conjointly, not in either alone, that the function of respiration essentially consists. It will be remembered that the carbonic acid

passes out through the animal membrane by exosmose, and the oxygen passes in by endosmose.

The sources of the carbonic acid given off in respiration are threefold: 1st. The continual decay of the tissues: which is common to all organized bodies; which is diminished by cold and dampness, and increased by warmth and moisture; which takes place with increased rapidity at the approach of death, whether this affects the body at large, or only an individual part; and which goes on unchecked when the actions of nutrition have ceased altogether.

2d. The metamorphosis which is peculiar to the nervous and muscular tissues; which is the very condition of their activity, and which therefore bears a direct relation to the degree in which they are exerted.

3d. The direct conversion of the carbon of the food into carbonic acid, which is peculiar to warm-blooded animals, and which seems to vary in quantity in accordance with the amount of heat to be generated.[1]

The organs of respiration are always formed upon the same general plan, being essentially membranous prolongations of the external surface, adapted by their permeability and vascularity to bring the blood into close relation with the surrounding medium.

As this medium may be either air or water, we find two principal forms of respiratory organs, one of which is adapted for each. In aquatic animals the membrane is usually prolonged externally into tufts or fringes, each one of which is supplied with arteries and veins, during the circulation through which the aeration is accomplished. These organs are called *gills*.

In air-breathing animals the aerating surface is reflected inwardly, forming passages or chambers into which the air is received, and on which the capillary vessels are distributed.

In insects we find a series of tubes called *tracheæ*, ramifying through the body and carrying air to every part of it. In these tubes there is a spiral deposit, (as is also seen in the sap-vessels of plants) upon their inner surface, the object of which is to keep the calibre of the tube always open.

In regard to the human lung, according to the observations of Mr. Rainey, a bronchus, when traced from its commencement to its termination, is seen in the first part of its course to be more or less cartilaginous; it then becomes destitute of cartilage, retaining, however, a perfectly circular form, and having no air-cells opening into it; farther on, being still circular, numerous air-cells open into it; lastly, the air-cells increase so much in number, and open into the bronchus so closely to one another, that the tube can no longer retain its circular

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[1] For a more detailed account of these sources of carbonic acid, of which the above is merely a recapitulation, see Carpenter's Principles of Human Physiology, 6th American edition, p. 281, and seq.

form, but becomes reduced to an irregular passage running between the cells, and, ultimately reaching the surface of the lobule, ends by forming a terminal air-cell.

The air-cells are small irregularly-shaped cavities, having usually four or five unequal sides; those which are situated close to the small bronchial passages, open into them by well-defined circular apertures, while those at a distance from these passages open one into the other, as in the lung of the frog and serpent; in fact, each lobule of the lung of the mammal and man, with its bronchial passages and appended cells, may be regarded as a repetition of the whole lung of the frog.

The sides or walls of the air-cells are formed of a thin transparent membrane, and the capillary vessels are so placed between the walls of two adjacent cells as to be exposed on their two sides to the action of the air. The number of capillary plexuses is not the same as that of the air-cells, one network passing between and supplying several cells; or in other words, one terminal branch of the pulmonary artery supplies the plexuses of several cells.

It has been calculated by M. Rochoux that as many as 17,990 air-cells are clustered around each terminal bronchus, and that their total number amounts to 600 millions.

The fœtal lungs, according to Mr. Rainey, prior to respiration, are distinctly seen, when injected, to possess air-cells fully formed, and surrounded, as in the animal which has respired, by plexuses of blood-vessels.

The chemical process of respiration is not essentially dependent on the respiratory movements. They merely serve to expel the air (or water) which has undergone the change induced by the chemical process constantly carried on between it and the blood, and to renew the supply of fresh air or water.

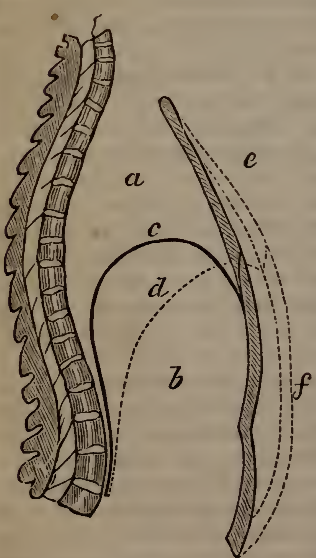
The lungs, by their internal surface, offer an immense expansion for the action of the blood and air on each other; and as they are never completely emptied by the act of expiration, this action is constant. By the contraction and dilatation of the chest, the motions of which the lungs follow, a portion of the altered contents of the pulmonary reservoir is first expelled, and then a new supply introduced, to undergo change in its turn.

According to the inquiries of M. Bourgery, the development of the air-cells continues up to the age of thirty, at which time the capacity of respiration is greatest; it subsequently decreases, especially in persons who suffer from cough. The violence of such expiratory efforts frequently causing rupture of the air-cells, thus gradually producing that emphysematous condition of the lungs so common in elderly people. The power of increasing the volume of air by a forced inspiration is much greater in young than in old persons, and is twice as great in males as in females of the same age, a circumstance which is evidently connected with the extent to which muscular efforts can be carried in these classes respectively.

Movements of Respiration.—These may be divided into two classes, those of *inspiration* and those of *expiration.* By the first is meant the action by which air enters the lungs; by the latter, the act of expelling from the lungs the air received in inspiration.

In mammalia generally, as well as in man, inspiration and expiration are performed by the dilatation and contraction of the cavity of the thorax. As soon as the walls of the chest are drawn wide asunder, and the thorax dilated, the external air rushes through the trachea and its branches into the air-cells, distending them in proportion to the dilatation of the thorax, thus keeping the surface of the lung accurately in contact with the thoracic walls in all their movements. This contact, however, can only take place while the thoracic cavity is closed on all sides, so that the air cannot exert any pressure on the *outer* surface of the lung, by which that upon the inner would be balanced. Hence it is, that in penetrating wounds of the chest, the lungs cannot be fully distended by inspiration, because the air entering through the wound into the cavity of the pleura balances the pressure of the air on the inner surface; the lungs, in such a case, remain collapsed, although the thoracic parietes dilate.

Fig. 187.



Section of thorax and abdomen. *a.* Thorax. *b.* Abdomen. *c.* Relaxed diaphragm. *d.* Contracted diaphragm.

Inspiration.—The diaphragm contributes the principal share to the dilatation of the chest during inspiration. In its relaxed state this muscle is arched; by contracting it becomes more plane; and by this flattening of its arch, the capacity of the thorax is increased, at the same time that the abdominal viscera are pressed upon from above, so as to produce the protrusion of the abdomen observed during inspiration. (Fig. 187.)

In a natural, tranquil inspiration, the dilatation of the chest is effected almost entirely by the diaphragm. The lateral dilatation, as in deep inspiration, is performed principally by the action of the intercostal muscles, assisted also by the scaleni, the levatores costarum, the serratus posticus inferior, and the thoracic muscles generally. In the old, inspiration is mainly accomplished by the diaphragm, in consequence of the ossification of the cartilages of the ribs.

The number of inspiratory movements varies greatly under different circumstances. In general it may be

stated from 14 to 18 usually occur in a minute; of these the ordinary inspiration involves but little movement of the thorax; but a greater exertion is made at about every fifth recurrence.

The average numerical proportion of the respiratory movements to the pulsations of the heart, is about 1 to 5 or $4\frac{1}{2}$, and when this proportion is widely departed from, there is reason to suspect some disorder of the respiratory apparatus or the nervous system.

Expiration, when perfectly tranquil, may be the result of the mere collapse or elastic reaction of the parts, recovering their natural state, after the active dilatation they have undergone; in fact, tranquil respiration seems to consist more in the periodic action of the muscles of inspiration, than in the alternate action of antagonizing muscles, Among the elastic components of the respiratory organs may be mentioned the cartilages of the ribs, the cartilages of the bronchial tubes, and the capsule of elastic tissue described by M. Bazin, which invests the lungs, and sends prolongations inwards, and the elasticity of the air-cells themselves. The muscles which are concerned in expiration are the abdominal, which draw down the ribs, and by compressing the abdomen force the viscera up against the relaxed diaphragm, and thus diminish the cavity of the thorax from below. These are the recti, obliqui, and transversi abdominis, the quadratus lumborum, the serratus posticus inferior, the sacro-lumbalis, and the longissimus dorsi.

If the whole time occupied by a respiratory act, from the beginning of one inspiration to the beginning of the next, be represented by 10, the inspiratory movement may be estimated at 5; the expiratory at 4; while the remaining 1 will be occupied by the period of repose which succeeds expiration.

The *capacity* of the lungs varies very much in different individuals. According to Mr. Hutchinson, by this term is meant "that quantity of air which an individual can force out of his chest by the greatest voluntary expiration, after the greatest voluntary inspiration." This author has shown that in health, this capacity bears a very constant relation to the height of the individual. Thus the mean "capacity" of 172 males under the height of 5 ft. 8 in. is 220 cubic inches, whilst that of 82 males from 5 ft. 11, to 6 ft. is 255 cubic inches. For every additional inch of height (from 5 to 6 ft.), 8 additional cubic inches are given out by a forced expiration. The exceptions to this occur among stout and corpulent individuals, whose capacity stands lowest. The size of the chest, therefore, is not always a criterion as to the capacity of expiration. Mr. Hutchinson also found that the full expiratory force of a healthy man is commonly one-third greater than his inspiratory force. The quantity that habitually and almost uniformly is changed in breathing, is called by Mr. Hutchinson *breathing air.* The quantity over and above this which a man can draw into the lungs in the deepest inspiration, he names *complemental air:* its amount is various, as has been shown. After ordinary expiration, such as that which expels the *breathing air,* a certain quantity

of air remains in the lungs, which may be expelled by a more forcible and deeper expiration: this he terms *reserve air.* But, even after the most violent expiratory effort, the lungs are not completely emptied; a certain quantity always remains in them, over which there is no voluntary control, and which may be called *residual air.* Its amount depends in great measure on the absolute size of the chest, and has been variously estimated at from forty to two hundred and sixty cubic inches.

According to the experiments of Mr. Coathupe, about 266⅓ cubic feet, or 460,224 cubic inches of air, pass through the lungs of a middle-sized man in 24 hours; reckoning the average number of inspirations at 16 per minute, this would give 20 to 25 cubic inches as the amount inhaled at each.

Residuary air.—Upon the residuary air, depends the lightness of the lungs, which enables them to float upon water: in fact, when once these organs have been distended by a full inspiration, no mechanical, or other power, can dislodge the air so as to cause them to sink in water. Upon this circumstance was based the hydrostatic test of infanticide. The residuary air also gives rise to the tympanic resonance on percussion.

In the act of inspiration the air within the lungs is alternately increased and diminished in amount; and thus a regular exchange is secured. This exchange, however, affects only a portion of the contained air at a time, and this proportion appears to vary according to the frequency of the respiration. Indeed, if it were not for the tendency of gases to mutual diffusion, the air in the remote cells might never be changed. Probably about one-eighth of the whole contents is changed at each inspiration. As long as the residuary air contains any oxygen, aeration of the blood will take place, provided always the heart continues to act; but as soon as the contained oxygen is consumed, asphyxia begins to occur, unless a fresh supply is obtained. The residuary air will probably support life about three minutes.

Influence of the nerves on respiration.—The source of the nervous influence on which the different respiratory movements depend, is one and the same, although the nerves implicated in these movements are very various. The *Medulla Oblongata* is the source from which the nervous influence for the respiratory motions is derived, and the spinal cord is, as it were, the trunk of the nerves which arise from it. If the spinal cord is divided above the point where the dorsal nerves are given off, the motions of the ribs and abdominal muscles are paralysed, while the other respiratory movements continue. If it is cut above the origin of the phrenic nerve, then the diaphragm is paralysed, while the nerves given off from the medulla oblongata itself still continue to exert their function. Injury of the *medulla oblongata* arrests instantly all the respiratory movements, both those dependent on the par vagum, and those on the spinal nerves.

The respiratory movements are partly voluntary, partly involuntary.

Partly voluntary, in order that they may be inservient to the production of vocal sounds, and to the actions of speech, singing, &c. Partly involuntary, lest in sleep, or in moments of forgetfulness, the movements of respiration should be suspended, and fatal results ensue.

The combined action of the respiratory muscles is under the influence of that portion of the nervous system called the *reflex;* a part which does not involve the will, or even sensation, and which may continue to transmit its influence when all the other parts of the nervous centres have been removed. The principal excitor, or *afferent* nerves, are the *par vagum*, and the sensory branches of the fifth pair, the former conveying impressions from the lungs, the latter from the general surface. If the par vagum be divided on both sides, the movements of respiration are greatly diminished in frequency.

Chemical phenomena.—The prominent phenomena in respiration are, the removal of a certain quantity of oxygen from the air, and its replacement by carbonic acid; and the change in colour of the blood from a dark venous hue, to a bright scarlet or arterial. The relative proportions of oxygen inhaled and of carbonic acid exhaled, are to each other inversely as the square roots of their specific gravities; that is, the quantity of oxygen absorbed will exceed that of carbonic acid given off in the proportion of 1174 to 1000. Carbonic acid contains precisely its own volume of oxygen; consequently, of the 1174 parts of oxygen absorbed, 1000 are again excreted as carbonic acid, leaving 174 parts, or nearly 15 per cent. to be accounted for. Some of this unites with the sulphur and phosphorus of the original components of the body; the remainder most probably enters into combination with the hydrogen of the fatty matter, thus forming part of the water exhaled by the lungs.

Of the nitrogen which enters so largely into the composition of atmospheric air, a small portion only is absorbed, in consequence of the difficulty with which it passes through animal membranes; its main use in the atmosphere being to dilute the oxygen. The exhalation and absorption of nitrogen appear usually to balance each other, so that the amount of this gas in the respired air undergoes little or no change.

The quantity of carbonic acid exhaled varies at different times, and under different circumstances. The mean of a great number of observations gives about 160 grains of carbon per hour as the quantity set free by an adult; this would give 8 oz. Troy in the 24 hours. The amount varies with the development of the body, and with the sex. In males, the quantity increases from eight years of age till thirty; it remains stationary till forty, and then decreases till old age, when it little exceeds that at ten. An extraordinary development of the muscular system is always accompanied by the extrication of a larger quantity; the reverse is also true.

In females there is the same proportional increase till puberty, from which time it remains stationary during the menstrual life; after

which it increases. After fifty, it decreases as in man. During pregnancy the amount of exhalation is increased, and the same takes place whenever the menses are temporarily arrested.

The quantity exhaled is also increased by cold, exercise, or a full meal, and by many of the exanthemata. It is diminished in typhus fever, in chronic diseases of the respiratory organs, and in sleep.

Independently of these variations, there is a difference in amount in accordance with the time of day, being least at midnight, gradually increasing till midday, then again declining till midnight.

The sources of the carbonic acid have been already adverted to. It is not formed in the lungs as was originally supposed, but in the tissues themselves, as is shown by the fact that venous blood contains a larger amount of this gas than arterial; and that an animal placed in hydrogen, or nitrogen, still continues to evolve carbonic acid.

In regard to the change of colour effected by respiration, it must be regarded as a purely physico-chemical phenomenon, inasmuch as the same changes will take place in blood exposed to the air out of the body, even through the medium of a thick membrane, such as a bladder. The precise cause of the change of colour is as yet unsettled. By Liebig it is supposed that the iron in the red corpuscles is the real agent in the respiratory process, and that the corpuscles are the carriers of oxygen into the system, and of carbonic acid out of it. He supposes the iron to exist in the form of protoxide in venous blood, united with carbonic acid, forming a carbonate of the protoxide of iron; in the lungs, the carbonic acid is given off, leaving the protoxide, which by union with half an equivalent of oxygen, is converted into the peroxide, at the same time that the colour is changed to arterial. In the systemic capillaries the reverse takes place, — the oxygen being imparted to the tissues, and replaced by the carbonic acid, which is given up by them to be conveyed out of the system.

Mulder, Scherer, and others, account for the change of colour, by a change of *form* in the red corpuscles, which are supposed to be bi-concave, and reflecting bodies in arterial blood, and bi-convex, and refracting bodies in venous blood. Mulder shows that the *colour* is not dependent on the presence of iron, since it is retained when all the iron has been entirely removed.

The presence of a certain amount of saline matters appears, from the experiment of Dr. Stevens, to be essential for the due influence of oxygen upon the colour of the blood; since, if they be deficient, the contact of oxygen will not produce its usual effect.

The blood parts with a considerable amount of water in the lungs, amounting to 16 or 20 ounces in 24 hours. It also absorbs volatile matters from the air. The water contains some animal matters, and has its source, according to Dr. Prout, in the chyle which has just been poured into the blood; probably also it escapes by evaporation through the thin animal membrane.

Asphyxia. — If from any cause the supply of oxygen be cut off, a

condition ensues to which the name of asphyxia has been given; the essential character of which, is the cessation of muscular movement, and shortly afterwards of the circulation, with an accumulation of blood in the venous system. The time necessary for the production of this state is inversely proportionate to the development of the respiratory functions; thus, warm-blooded animals are much sooner asphyxiated than reptiles. In the former, deprivation of air for two minutes is sufficient to produce insensibility and loss of muscular power. The circulation generally fails within ten minutes.

The first effect of non-arterialization of the blood in the lungs, is the retardation of the fluid in their capillaries, an accumulation in the venous system, and a deficient supply to the arterial. The operation of these two causes arrests the action of the heart, although the effect on the two sides is different; the right side ceases to act from overdistension; the left, from deficiency of stimulus to excite the movement. If the stoppage have not been too long, the heart's action may be renewed by artificial respiration; for the replacement of oxygen in the air-cells restores the pulmonary circulation, and thus, at the same time, relieves the distended right ventricle, and conveys to the left the due stimulus to its action. In conclusion, it may be stated, that the post-mortem appearances are always the same in asphyxiated individuals, no matter what may have been the mode of death.

CIRCULATION.

By this term is understood that function by which the nutritive fluid is conveyed to every part of the body through appropriate channels. This distribution is spoken of under the general title of *The circulation of the blood;* the organs and canals by means of which and through which it is accomplished constitute the *vascular system.*

The greater circulation was discovered in the higher animals by William Harvey in 1619, and although it cannot be asserted to be an universal character of all animals, yet at every advance of observation, new traces of vessels are discovered in the most simple beings.

There is a circulation in plants as well as in animals, and its object is the same. There is no central organ, however; the elaborated sap is distributed partly by vis à tergo, partly by capillary action, and the influence of light and air upon the leaves, but mainly by the affinity between the elaborated sap and the tissues of the plant.

In the organic cells of plants there is a circulation in their interior, upon their inner walls, which has never been satisfactorily explained. It consists in a regular movement of a viscid fluid, without any apparent impelling power. It ascends against gravity, and sometimes communicates its movements to the nucleus. In this movement the chlorophyll granules participate, and the movement in each cell seems to be independent of its neighbours. It probably exists also in the organic cells of animals. It is called *cyclosis*, and has recently been attributed to the action of cilia on the interior walls of the cell.

In the higher orders of animals, there are two distinct circulations, with a heart for each. These two circulations are entirely separate and distinct from each other in the perfect adult, as are also the hearts belonging to each, being merely brought together for economy of material and space. They are called the greater and the lesser; or the systemic and pulmonic.

The course of the blood through these two circuits, may be likened to the figure 8; and the heart is placed at the junction of these. Each system has its own set of arteries or efferent trunks, or veins or afferent trunks; these communicate at their central extremity by the heart; and at their peripheral extremity by the capillary vessels, by which are meant the minutest ramifications of the two systems inosculating into a plexus.

The route of the circulation is as follows: the venous blood is collected in the right auricle, thence it passes through the tricuspid orifice into the right ventricle; thence it is distributed to the lungs through the pulmonary artery to be aerated, after which it is collected by the pulmonary veins and carried to the left auricle, from which it passes through the mitral orifice into the left ventricle, and from thence through the aorta to the system.

The chief impelling power of the circulation, is the rhythmic motion of the heart. This organ is endowed in a remarkable degree with the property of *irritability* or *contractility;* by which is meant "the capability of being easily excited to movements of contraction alternating with relaxation." This property is an endowment strictly belonging to the heart, and is not derived from any connexion with the nervous system, since it has been shown to continue after all connexion has been severed. It is retained much longer in the cold-blooded than in the warm-blooded animals; and in the very young animals than in the old.

This movement of the heart cannot be accounted for by the stimulus of the blood, since it will continue when the heart is empty; nor yet by the stimulus of *air,* since it persists even *in vacuo;* and it has been shown above that they are independent of the nervous system; they must therefore depend on the *vis insita,* though the exciting cause cannot be positively determined.

If the heart of a living mammiferous animal or bird is laid bare, the two ventricles are seen to contract together; and the two auricles, with the commencement of the pulmonary veins and of the venæ cavæ almost simultaneously; the contraction of the auricles and that of the ventricles, however, *not being synchronous.* The contraction of all the cavities is followed by their dilatation; the contraction is called the *systole;* the dilatation, the *diastole.*

The auricles are but little concerned in the propulsion of the blood, they being mere sinuses or receptacles. The *systole* of the ventricle corresponds with the projection of the blood into the arteries,

causing the pulse; whilst the diastole coincides with the collapse of these vessels.

When the ventricles contract, the blood is prevented from returning into the auricles by the tricuspid valve, on the right side; and by the mitral valve on the left. But in some circumstances the closure of the tricuspid valve is not complete, and a certain quantity of blood is forced back into the auricle; and, since this may be advantageous, by preventing the over-filling of the vessels of the lungs, it has been called the *safety-valve action* of this valve (Hunter, Wilkinson King). The circumstances in which it usually happens are those in which the vessels of the lung are already full enough when the right ventricle contracts, as *e. g.* in certain pulmonary diseases, in very active exertion, and in great efforts. In these cases, perhaps because the right ventricle cannot contract quickly or completely enough, the tricuspid valve does not completely close, and the regurgitation of blood may be indicated by a pulsation in the jugular veins synchronous with that in the carotid arteries. When the ventricles dilate, the blood is prevented from re-entering their cavities, by the semilunar valves at the mouth of the aorta and pulmonary artery. The dilatation of the ventricles may be distinguished into two stages: the first immediately succeeds their systole, and manifests itself in the recession of the heart's apex from the walls of the chest; the second stage is attended with the enlargement of the heart in all directions, and is synchronous with the auricular contractions. It is between these two stages that the interval of repose takes place.

The diastole of the heart, according to Cruvelhier, is an active force, but of its cause no precise account is given. It is supposed to be owing to the presence of the yellow fibrous tissue, interwoven with the muscular substance, upon whose elasticity the first stage of the ventricular diastole is supposed to depend; the second stage being caused by the ingress of blood produced by the auricular systole. It is during the *diastole* of the heart that the *impulse* occurs.

The impulse of the heart must not be confounded with the arterial pulse. The heart's impulse is the shock communicated by its apex to the walls of the thorax in the neighbourhood of the fifth and sixth ribs.

Sounds of the heart. — When the ear is placed over the præcordial region, two sounds are heard, following each other in quick succession, at each beat of the heart. These sounds are followed by a short interval of repose, after which they recur, again followed by repose, and so on. The sounds are of different lengths; the *first* being the longest. If the whole interval, from the beginning of one pulsation to the beginning of the next, be divided into four equal spaces of time, the first two will be occupied by the first sound, the third by the second sound, while the fourth will represent the period of repose.

The first sound coincides with the second stage of ventricular

diastole, with the systole of the ventricles, the pulse in the arteries, and the impulse against the walls of the chest. The second, with the first stage of the diastole of the ventricles. The first is a dull, prolonged sound, the second is short and sharp, and follows so immediately upon the first that it can hardly be imagined to occur during the systole of the auricles, as has been supposed.

The *causes* of these sounds have given rise to much discussion. The first is evidently complex, having several elements in its composition. The principal cause of it is found at the orifices of the aorta and pulmonary artery, and is produced by the rush of the blood through these comparatively narrow outlets. Another element is found in the passage of the blood over the rough internal surface of the heart; a third element, in the sound of muscular contraction accompanying the systole of the ventricles; and a fourth in the *impulse* of the heart against the walls of the chest; for when the impulse is prevented, the sound is much diminished.

In regard to the *second* sound, which accompanies the first stage of the *diastole* of the ventricles, there is not so much doubt. It is produced by the sudden shutting down of the semilunar valves at the orifices of the aorta and pulmonary artery, the function of which valve is, to prevent the reflux of the blood into the ventricles during their dilatation.

To sum up, the causes of the *first sound*, are: 1st. The rush of blood through the narrow orifices of the aorta and pulmonary artery and auriculo-ventricular orifices; 2d. The passage of the blood over the rough internal surface of the ventricles; 3d. The sound of muscular contraction; 4th. The impulse against the chest. The cause of the *second sound* is, the sudden shutting down of the semilunar valves at the orifices of the aorta and pulmonary artery.

The following table will perhaps assist the student in connecting the sounds of the heart with its movements:

First Sound.	Second stage of ventricular diastole. Ventricular systole, and auricular diastole. Impulse against the chest. Pulse in arteries.
Second Sound.	First stage of ventricular diastole.
Interval.	Short repose; then auricular systole, and second stage of ventricular diastole, &c.

The *capacities of the different cavities* of the heart are said to vary slightly, as well as the *thickness of the walls;* the right auricle and ventricle are said to be most capacious, while the left auricle and ventricle have the advantage in thickness of their walls; the left ventricle having its parietes nearly three times as thick as the right, since it has to exercise more force in sending the blood to the distant parts of the system.

Each cavity will hold about two fluidounces, but it is probable that

the ventricles do not entirely empty themselves at each stroke; they will therefore discharge about $1\frac{1}{2}$ ounces at each pulsation. Reckoning 75 pulsations in a minute, there will pass through the heart in this time, 112 oz., or 7 lbs. of blood. The whole quantity of blood in the human body is equal to about $\frac{1}{5}$th of its weight, or 28 lbs. in a person weighing 140 lbs. This quantity would therefore pass through the heart once in four minutes, and would circulate about fifteen or twenty times in an hour.

Recent experiments would seem to show that this is below the estimate, since substances introduced into the venous circulation have been detected in the remotest parts of the arterial system in less than 30 seconds.

The *force* with which the heart propels its blood has been variously stated. According to Hales, the usual force of a man's heart would sustain a column of blood $7\frac{1}{2}$ feet high, the weight of which would be about 4 lbs. 6 oz. According to Poisseuille, who caused the blood to act upon a column of mercury, the force of the heart is equal to 4 lbs. 3 oz. The true estimate of this force is found by multiplying the pressure of blood in the aorta into the surface of a plane passing through the base and apex of the left ventricle; according to which it is found to be about 13 lbs.

The number of contractions of the heart in a minute, is about 70 or 75. The frequency of its action gradually diminishes from the commencement to the end of life. Just after birth, it ranges from 140 to 130; in old age, 65 to 50. Age, sex, muscular exertion, emotions, and temperament, exert a controlling influence over the heart's action. In persons of sanguine temperament, the heart beats more frequently than in those of the phlegmatic, and in the female sex more frequently than in the male. Its action is also increased after a meal, and by rising from a recumbent, to a sitting or standing posture. The time of day also affects it; the pulse is more frequent in the morning, and becomes gradually slower as the day advances.

In inflammations and fevers, the pulse is much more frequent than during health. When the vital powers decline, it becomes frequent and feeble. In nervous affections, with more oppression than exhaustion of the forces, the pulse is often remarkably slow.

MOVEMENT OF THE BLOOD IN THE ARTERIES AND CAPILLARIES.

By the action of the left ventricle, the blood is forced onwards and distributed throughout the whole body, with the exception of the lungs, and passes through the capillaries into the veins.

The pressure of the column of blood against the elastic walls of the arteries, at every contraction of the ventricle, produces what is called the *pulse*. The sensible pulse of the arteries is synchronous, or nearly so, with the contraction of the ventricle; it is somewhat later than the heart's beat, especially in the distant vessels, but the difference

of time is scarcely perceptible. In the capillaries and veins, the pulse is no longer perceived.

There is found to be a very close correspondence between the areas of the branches and that of the trunk from which they spring. According to a well-known geometrical law, the areas of circles are as the squares of their diameters. Now, if we add together the squares of the diameters of the branches of a given vessel, we will find that their sum is about equal to the square of the diameter of the parent trunk, showing that the conjoint size of the branches is not greater than that of the main trunk, and that the vascular system cannot be compared to a cone whose apex is at the heart, and whose base is at the circumference of the body, with a regularly increasing surface; but rather to a cylinder, whose diameter is equal throughout, and the pressure upon whose walls is at every point the same.

The arteries are possessed of three coats, an external, cellular; a middle, composed of muscular fibres and yellow fibrous tissue; and an internal, which is serous. Upon the *elasticity* of the yellow fibrous tissue is dependent the property by which the interrupted force of the heart is made equable and continuous, and which is seen most in the large vessels connected with that organ. The *contractility* of the muscular fibres, which they have been shown to possess, is concerned in regulating the flow of blood towards particular organs. Their contractility is most plainly seen at a distance from the heart, where the impelling power of this organ becomes almost null. Under these circumstances, the muscular coat becomes an important adjuvant.

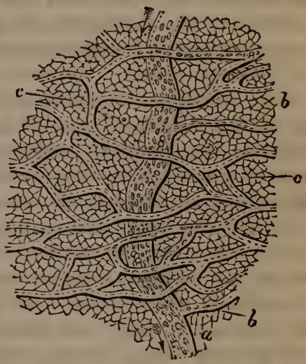
The muscular coat has also another function, that of *regulating* the diameters of the tubes in accordance with the quantity of blood to be conducted through them to any part; this is seen in the enlargement of the uterine and mammary arteries, during pregnancy and lactation, and in their return to their normal size after these periods are over. These changes are due to the contractility of the muscular fibres of the middle coat, probably regulated by the sympathetic nerve, which is minutely distributed upon the vessels. In the permanent dilatation of arteries, however, in parts that are undergoing enlargement, their nutrition is also increased, the walls being thickened as well as extended.

In addition to the elasticity and contractility already described, experiment indicates the existence of that power of *slow* contraction in the arteries to which the name of *Tonicity* has been given; this, however, does not seem to be anything else than a particular manifestation of the general property of vital contractility, and is quite distinct from ordinary elasticity. The manifestation of this property is seen when a ligature is applied to an artery, the part beyond the ligature becoming gradually smaller, and emptied to a greater or less degree of the blood which it contained. The empty condition of the arteries after death is due to the same cause. It is to the moderate action of the *Tonicity* of arteries, that these contractions upon the stream of

blood passing through them, is due. If the tonicity be excessive, the pulse is hard and wiry; but if it be deficient, the pulse is very compressible, though bounding, and the flow of blood through the arteries is retarded.

The smaller arteries in every organ of the body, before they become capillary, are connected by repeated anastomoses with each other, the object of which arrangement is, to supply the circulation to any part, when an important vessel leading to that part is either compressed or obliterated. The capillary system of all connected parts being continuous, all the vessels, whether arteries or veins, are united through its medium.

Fig. 188.



Capillaries in the web of the frog's foot, magnified.

CAPILLARIES.—It has been shown that in all organic textures the transmission of the blood from the minute branches of the arteries to the minute veins is effected by a network of microscopic vessels, in the meshes of which the proper substance of the tissues lies. These minute vessels are called *capillaries*, from their small size; and they may be seen by the aid of the microscope in the web of the frog's foot, in the tail of the tadpole, and the lungs, urinary bladder, or tongue of the frog. (Fig. 188.)

The *size* of the capillaries is proportioned to that of the red particles of the blood, and can be measured in parts finely injected. Their diameter varies from $\frac{1}{1000}$th to $\frac{1}{4000}$th or $\frac{1}{5000}$th of an inch. When filled with blood they are not so much distended as when injected, and have seldom been measured when so filled. No other elementary tissues are much more minute than the capillaries.

Microscopic observations and minute injections have shown that the capillary vessels are merely the fine tubes which form the medium of transition from arteries to veins, and that *no other kind of vessels arise from them;* that the minute arteries have no other mode of termination than the communication with the veins by means of capillaries; in a word, *that there are no vessels terminating by open extremities* (Muller.) *Serous vessels*, that is, branches of the blood-vessels too minute to allow the passage of red particles, and consequently traversed merely by the lymph of the blood, may *possibly* exist, though they have not been demonstrated. What have probably been mistaken for them, are vessels which are so small as to admit only a single row of blood-corpuscles, the amount of colouring matter in which is not sufficient to tinge the light transmitted through them. The existence of

vessels in the substance of the cornea, which were supposed to be *serous* or white vessels, is, according to Müller, very doubtful; they have never been injected.

The existence of membranous parietes in the capillary system has been doubted by many physiologists, but more accurate research seems to establish the fact that such is the case. The fact that fluids injected into the arteries pass into the veins without extravasation, and that currents cross above and below each other without mixing, have been adduced as arguments for the existence of membranous walls. Besides which, Windischmann has dissolved away the other tissues in a delicate membrane found in the ear of birds, leaving the beautiful vascular network, with the meshes empty. Schwann has also discovered by the microscope, that the capillaries have not merely membranous parietes, but a coat in which circular fibres can be distinguished as in the arteries.

The capillary circulation seems to be in a great degree independent of the heart's action, since it has been seen to continue in cold-blooded animals after complete excision of the heart. The emptiness of the arterial system after death, although partly owing to the *tonicity* of the arteries themselves, is commonly more complete than could be thus accounted for, and must therefore be partly due to the capillary circulation. Farther, the process of secretion, which could not take place unless the capillary circulation were still continued, has also been seen to continue after death. In the embryo, the blood circulates *before* the heart is formed; and instances are not wanting in which the heart was entirely absent during embryonic life, and yet the greater part of the organs were well developed. In the latter case the circulation must be due to capillary power. The local determination that takes place whenever the processes of nutrition and secretion are carried on, and the increased rapidity of the movement without corresponding increase of the heart's action, also go to support the idea of an independent capillary power.

These facts, and others to prove that the circulation in a part may be arrested, while the heart is still acting, and the vessels pervious, seem to be favourable to the belief in the existence of such a power.

In regard to the *nature* of the power, it cannot be *mechanical*, since no movement of contraction or dilatation has ever been seen. The conditions under which the power in question uniformly operates, may be thus expressed:—"Whilst the injection of blood *into* the capillary vessels of every part of the system is due to the action of the heart, its rate of progress *through* those vessels is greatly modified by the degree of activity in the processes to which it should be normally subservient in them;—the current being rendered more rapid by an increase in their activity, and being stagnated by their depression or total cessation."

Thus the capillaries seem to have a *distributive* power over the

blood, regulating the local circulation independently of the heart's action, and in obedience to the necessities of each part.[1]

The views of Prof. Draper in relation to the dependence of the circulation of the sap in plants upon chemical changes in the circulating fluid, assist to explain very satisfactorily the capillary circulation in animals. A brief and modified summary of these views is here given. Experiments on inorganic bodies show, that if two liquids communicate with each other through a capillary tube, for the walls of which they have an unequal affinity, the liquid which has the greater affinity will be absorbed most energetically, and drive the other before it. This is what seems to take place in the organized tissues, permeated by nutritious fluid. The particles of this fluid, and the solid matter through which it is distributed, have a certain affinity for each other, which is exercised in the nutritive changes, to which the fluid becomes subservient during the course of its circulation. Certain matters are drawn from it in one part to carry on the nutritive process; in another, to accomplish the function of secretion. The fluid, which has given up to one tissue some of its materials, has no longer the same affinity for that tissue; it is consequently driven from it by the superior attraction then possessed by the tissue for another portion of the fluid containing the required ingredients; this in its turn is rejected for a fresh supply.

But the fluid, thus repelled from one part, may still be attracted towards another; because that portion of its contents which the latter requires may not yet have been abstracted; and thus the flow of the blood is maintained through the capillary network until it is altogether exhausted of its nutritive matter.

Although the circulation is not *dependent* upon nervous power, its influence is nevertheless manifest, as is occasionally seen in the functions of nutrition and secretion, by the control it exerts over the diameter of the blood-vessels. The phenomena of blushing, pallor, and the erection of certain tissues, are also examples of a modified condition of the blood-vessels through the agency of this system.

THE VENOUS SYSTEM arises in the small trunks formed by the union of the capillaries; and it returns the blood to the heart. These vessels are possessed of the same number of coats and the same properties as the arteries, only not so strongly developed. The internal membrane is thrown into valves or folds to prevent the reflux of the blood. The *capacity* of the venous system is said to be considerably greater than the arterial, holding two or three times as much blood as the latter.

The venous circulation is mainly due to *vis à tergo;* it is assisted, however, by *vis à fronte*, in the *suction power* of the heart. The *inspiration of venous blood* is also said to assist it. By this is meant

[1] Carpenter's Principles of Human Physiology, p. 274.

the rush of blood towards the chest, in order to supply the vacuum created there by the descent of the diaphragm. That it has some influence is seen in the partial emptying of the veins in inspiration, and their turgidity in expiration. But that it can have no *general* influence over the venous circulation, will perhaps be seen from the fact that the pulmonary circulation, being entirely within the chest, cannot be affected by atmospheric pressure, and also that the circulation of the fœtus in utero cannot be aided by any such agency.

Muscular movements are among the most important adjuvants to the venous circulation, every contraction being accompanied by a pressure upon the veins of the part; and as the blood is prevented by the valves from flowing back into the small vessels, it must be driven on towards the heart. This is familiarly seen in blood-letting, every movement of the hand increasing the flow of blood from the orifice.

A few of the peculiarities of the circulation may be mentioned in conclusion. These are first, in the *pulmonary circulation*, in which *venous* blood is sent from the heart, and through a tube which is *arterial* in its structure; whilst *arterial* blood is delivered to the heart through several venous trunks.

The *Portal circulation* is also peculiar in its arrangements, the venous blood ramifying through vessels disposed like arteries, and having to overcome the resistance to an additional capillary system in the liver, before reaching the heart.

The portal circulation is entirely independent of the pulsations of the heart, and differs from all other venous circulations in the fact that there is an intervening organ between the vein and the heart. The blood, instead of passing directly from the portal vein to the heart, is forced to traverse an organ seated upon its course to the centre of circulation. The portal, and indeed the circulation in all the abdominal viscera, is under the direct influence of the pressure of the abdominal walls. This pressure is essential and indispensable to the circulation of the blood through the abdominal organs, and particularly so to its passage through the portal system. If a small opening be made in the abdomen of an animal, a portion of intestine be withdrawn, and a hydrometer be placed in one of the veins and the intestine returned into the abdomen, an oscillation will be observed in the tube at each inspiration. The blood is elevated in the tube, because at each inspiration the abdominal cavity is diminished by the descent of the diaphragm and the contractions of the muscles. A notable pressure is thus applied to the contents of the cavity, which is in some degree measured by the elevation in the tube. The pressure is increased or diminished in proportion to the depth of the inspiration. If, after the introduction of the instrument, the walls be largely opened, the oscillations will cease, because the pressure is obstructed. In this case the elevation will not only cease, but there will be a counter-current or regurgitation from the inferior vena cava and liver into the vena portæ and mesenteric veins. If prussiate of potash be placed

in the inferior cava, by means of a tube, and the abdomen opened, it will regurgitate with the current of blood into the vena portæ. This regurgitation occurs in paracentesis abdominis for ascites; the pressure is removed and hence the syncope. The portal circulation is then entirely dependent upon the abdominal pressure, which last is dependent upon respiration.

The *Erectile tissues* appear essentially to consist of a plexus of varicose veins, enclosed in a fibrous envelope, which plexus, according to Gerber, is traversed by numerous contractile fibres, to the contraction of which is probably to be attributed that obstruction to the return of blood by the veins, which is the occasion of their turgescence. It is maintained by Kölliker that the function of the contractile fibres is to compress the veins in the intervals of erection, so as to prevent their being distended, and that through the influence of the nervous system these fibres are relaxed, and an increased influx of blood permitted. He advances in support of this idea, the fact that warmth favours erection by relaxing muscular contraction, whilst cold prevents it. In the penis, according to Müller, there are two sets of arteries, one destined for the nutrition of the organ, the other, by communicating with venous cells, for its erection. In the erectile tissues, erection may ensue either from local irritation, or as a result of certain emotional conditions of the mind, the influence of which is probably transmitted through the sympathetic nerve.

NUTRITION.

According to the definition of Adelon, nutrition is the action by which every part of the body, on the one hand, appropriates or assimilates to itself a portion of the blood distributed to it, and, on the other hand, yields to the absorbing vessels a portion of the materials that previously composed it. The process of nutrition is not an object of microscopic observation; the precise mode, therefore, in which it is accomplished, is not accurately known. The *source of all nutrition and of all growth is the blood*, from which the materials are shed or separated, to be employed in the renovation and reparation of the tissues. This is obviously only to be accomplished by the parenchyma selecting from the capillaries and intermediate vessels those ingredients that can become inservient to this process. The structure composing every separate portion of the body has what may be called an *elective affinity* for some particular constituents of the blood; causing it to abstract from that fluid, and to convert into its own substance, certain of its elements. The *selecting power*, possessed by the component cells of every tissue, is exercised not only upon the materials required for their development, but even upon substances abnormally present in the blood: thus arsenic will produce irritation of the mucous membranes of the body; and the continued introduction of lead into the circulating system modifies the nutrition of the extensor muscles of the forearm, producing the phenomena of *lead palsy;* the existence of this

modification is proved by chemical analysis, which reveals the existence of lead in the palsied muscles. Substances thus introduced into the blood affect the symmetrical portions of the body; thus the extensor muscles in both arms are paralysed; and the cutaneous eruptions produced by the internal exhibition of certain remedies, are found to be almost precisely symmetrical; the presence of the medicine in the blood being the occasion of a disordered nutrition of certain parts of the skin; and the selecting power of particular spots being evinced by the exact correspondence of the parts affected on the two sides.

In the process of nutrition is exemplified the fundamental principle of organic assimilation. Each elementary particle of an organ attracts similar particles from the blood; and by the changes it produces in them, causes them to participate in the *vital principle* of the organ itself. Nutrition does not consist merely in the component particles of the organs attracting the fibrine, albumen, and other materials of the blood which flow through them, adding to themselves the matters similar to their own proximate principles, and changing the composition of those which are dissimilar; but the assimilating particles must infuse into those newly added to them their own vital properties. Mere increased size is not nutrition; parts may be increased in size by the deposition of fibrine, as in inflammation, but this fibrine is unassimilated, and not endowed with the vital properties of the tissue in which it is deposited, and in this consists the difference between increased nutrition and increased size. It was said that the source of all nutrition was the blood: a short account of this fluid may be necessary here. The *chyle* and the *lymph*, which are also generally considered as nutritive fluids, have been already described under the head of Absorption.

The blood, whilst circulating in the living vessels, consists of two parts, — a thin, transparent, nearly colourless liquid, termed *liquor sanguinis;* and a number of small bodies, called the *red corpuscles*, from which the colour of the blood of vertebrated animals derives its peculiar hue; in addition to which are found some *white* or *colourless* corpuscles.

When the blood has been drawn from the body and allowed to stand, a spontaneous coagulation takes place, dividing it into *crassamentum* and *serum*. The crassamentum, or clot, is formed by the union of the fibrine and red corpuscles, by the entanglement of the latter in the meshes of the former. Whilst the serum is merely the liquor sanguinis deprived of its fibrine. From the fact that the serum coagulates by the addition of heat, we know that it contains albumen; by exposure to a high temperature, the animal matter is decomposed, and a considerable quantity of earthy and alkaline salts remain.

The distribution of these constituents in living and dead blood may be seen in the following table.

Living blood.	Fibrine, Albumen, Salts,	In solution, forming Liquor Sanguinis.
	Corpuscles.—Suspended in Liquor Sanguinis.	
Dead blood.	Fibrine, Corpuscles,	Crassamentum, or clot.
	Albumen, Salts.	In solution, forming serum.

The mean proportion of these different ingredients in a thousand parts of blood may be thus stated: *Fibrine*, 3 parts; *Albumen*, 80 parts; *Red Corpuscles*, 127 parts; *Water* and *Salts*, 790 parts. These proportions are subject to considerable variations within the limits of health. There is also a small amount of fatty matters and extractive. The following is the analysis of Simon made upon the blood of males: *Water*, 791·9; *Fibrine*, 2·0; *Corpuscles*, 114·3; *Albumen*, 75·6; *Extractive Matters* and *Salts*, 14·2; *Fatty Matters*, 2·0. There is a greater amount of solid matter in the blood of the male than of the female, except in the case of *albumen*, which is in larger quantity in the female.

Each of the prominent constituents of the blood has been already described in the earlier pages of these divisions, to which the reader is referred.

When the blood is examined shortly after a meal the serum is found to present a milky appearance. According to Drs. Buchanan and R. D. Thompson this appearance is due to the admixture of the *chyle*. The period at which the discoloration is greatest, however, and the length of time during which it continues, vary according to the kind and quality of the food, and the state of the digestive functions. The milkiness seems to be entirely due to the presence of oleaginous matter in the food. The crassamentum of such blood often exhibits a pellucid fibrinous crust, sometimes interspersed with white dots; and this seems to consist of an imperfectly-assimilated proteine-compound, analogous to that found in the serum. A small quantity of sugar is occasionally found, even in healthy blood, when large quantities of it are taken as food. But commonly it is transformed into lactic acid, or into fatty matter, before it is received into the circulating current.

By some physiologists the coagulation of the blood is looked upon as a mere physical process, dependent upon the exposure of the fluid to the air, precisely as some chemical substances are known to solidify under similar circumstances; and the long delay of the coagulation after death is mentioned as confirmatory. By others it is contended that the coagulation is the last act of vitality of the blood, which is evident from the incipient organization which may be detected even in an ordinary clot; and still more from the fact, that if the effusion of fibrine take place upon a living surface, its coagulation is the first act of its conversion into solid tissues possessing a high degree of vitality. If not within the influence of a living surface, it soon passes into a state of decomposition.

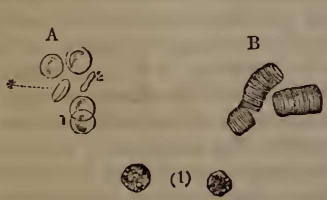
The rapidity of the coagulation depends very much upon the circumstances in which the blood is placed. It is accelerated by moderate heat, and retarded, though not prevented by cold. The blood that flows *last* from a vessel coagulates more rapidly, but less firmly, than that first drawn; and in inflammatory blood, in which the fibrine is increased, coagulation is unusually slow.

In certain disordered conditions of the blood, the surface of the clot is not unfrequently covered with a layer of fibrine nearly free from colour, and known as the *buffy coat.* This is commonly looked upon as positive evidence of the existence of inflammation. Such is not really the case, however, since it is seen in very opposite conditions of the system, as in chlorosis. In inflammation the amount of fibrine is really increased, and the coagulation of the blood is much retarded. This allows the corpuscles time to sink to the bottom, leaving the upper part of the clot composed of fibrine alone, which is nearly destitute of colour and very tenacious in its character, while the lower part obtains its deep red colour from the presence of the red particles. The layer of fibrine in its coagulation undergoes contraction of its edges, thus giving rise to the cupped appearance of inflammatory blood. The buffy coat is also seen in the blood of pregnant females; and also in that of chlorotic patients, in whom the fibrine is *relatively* in excess over the red corpuscles.

In idiophatic fever the amount of fibrine is lessened; should inflammation supervene, however, the fibrine is increased. The increase here is not due to the febrile condition, but to the local inflammation, which, according to Andral, is always accompanied by an increment in the amount of fibrine.

The corpuscles of the blood, in coagulating, apply themselves to each other so as to resemble piles of money. It is said that in inflammatory blood they are more closely applied, and the areolæ between the piles are larger than in healthy blood. Fig. 189 represents this arrangement, and the shape of the corpuscles.

Fig. 189.



A. Blood-corpuscles, seen on their flat surface and edge. B. Congeries of blood-corpuscles in columns.

The *materials* of the nutritive process being prepared in the blood, every tissue and every organ attracts from it particles similar to itself, or metamorphoses the proximate principles of the blood into its own elements. The blood is distributed to the tissues by the capillary system of vessels, with a degree of minuteness varying with the activity of the nutritive operations taking place in the individual parts. It is in the capillary system that all nutrition takes place, the

plastic material being selected, as before described, by the component cells of the tissue to be nourished.

The mode in which the tissues are developed by cells, has already been explained. It was then shown that in the production of any given form of tissue, nature does not at once unite the organic molecules in that form, but that she first creates in a structureless fluid, or in previously-existing cells by a definite process, round vesicles or cells, and subsequently transforms these into the various elements of the organic textures.

The process of nutrition varies greatly according to age, constitution, idiosyncrasy, state of health, &c. It is most rapid in youth, during the growth of the body; it is greatly less in old age; but differs widely with reference to particular organs. Morbid conditions, excessive bodily and mental efforts, the depressing emotions, such as care and sorrow, are all incompatible with perfect and powerful nutrition, and induce wasting of the several organs. As a general rule it may be stated, that the greater the demand for the functional activity of the organ or tissue, the more energetic is its nutrition, and *vice versâ.* Whenever the amount of nutritive material deposited in a tissue or organ is more than sufficient to supply the waste, the part becomes *hypertrophied* or *over-nourished.* The term hypertrophy signifies *excessive nutrition.* It differs from healthy nutrition only in degree. It consists in the augmentation of one or more of the natural constituents of an organ, in such a manner that the newly-formed parts are continuous with those already existing, and cannot be anatomically distinguished from them. Hypertrophy is never known to affect the *whole* body, to a degree sufficient to constitute disease. But examples of hypertrophy of particular organs or tissues are very common. *Atrophy*, or diminished nutrition, is exactly the reverse of the condition just described, but is more generally a morbid operation, and may affect either the whole body or individual parts. It takes place whenever the waste of the tissues is more rapid than their replacement by nutrition.

The nutritive operations, by which lost parts are repaired, take place with great activity. In its most perfect form, this process is analogous to that of the first development of the corresponding parts, and its results are as complete in the one case as in the other.

The reparative process was formerly thought to depend on the existence of inflammation; it can be shown, however, that in the majority of instances inflammation is injurious rather than beneficial.

"That the powers of reparation and reproduction are in proportion to the indisposition or incapacity for inflammation; that inflammation is so far from being necessary for the reparation of parts, that in proportion as it exists, the latter is impeded, retarded, or prevented; that, when inflammation does not exist, the reparative power is equal to the original tendency to produce and maintain organic form and

structure; and that it then becomes a natural function, like the growth of the individual, or the reproduction of the species."[1]

The continual death, or destruction of the individual cells which enter into the composition of the organs or tissues, constitutes what is called *molecular death*, to distinguish it from *somatic death*, or the death of the *whole body*, which follows upon the cessation of the respiratory and circulatory functions. Molecular death, however, is not always an immediate result of somatic death, since it is known that the lives of individual parts may be prolonged after the suspension of the regular series of their combined operations; so on the other hand, molecular death may take place to a considerable extent if the function of the part have no immediate relation to the indispensable actions just alluded to, without somatic death necessarily resulting.

There is no valid reason for believing that the processes of nutrition are *dependent* upon nervous influence, although, as before stated, it is known that they may be influenced by it. These processes go on with great regularity and rapidity in the vegetable kingdom, in which nothing approaching to a nervous system exists; and in the animal kingdom they take place long before any nervous system begins to be developed; the conversion of the primary cells into muscular tissue, bone, and mucous membrane takes place in virtue of the inherent properties of the primary tissue itself, since no nervous influence can be supposed to operate before nerves are called into existence.

SECRETION.

Nearly allied to the function last considered (nutrition) is that of *secretion*, which means literally *separation*. In both, certain materials are separated from the blood; in nutrition, the object of the separation is to build up the living body; in secretion, to get rid of certain useless substances, or to supply certain other combinations that may either directly or indirectly be essential to the economy.

The essential character of the true secreting process seems to consist not so much in the nature of the action itself, for this is identical with that of nutrition, both being effected by a process of cell-growth, but in the position in which the cells are developed, and the manner in which their products are disposed of. In secretion, the product of the action of the cells is delivered upon a free surface, communicating, more or less directly, with an external outlet, or into cavities provided with orifices that lead to them.

The organs by which the latter operations are effected, are called *secreting organs*, and the matters separated are spoken of as *secreted fluids*, or simply as *secretions*.

A distinction has been made between those secretions that are produced with an ulterior view as means to other functions in the economy,

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[1] Treatise on Inflammation, p. 7, by Dr. Macartney.

such as the saliva, gastric juice, &c., and those that are immediately rejected from the organism as useless, as for example, the urine, &c. The first are regarded more peculiarly as *secretions;* the latter, as *excretions.*

Of the reason why one organ should separate bile, another milk, and another sperm, no other account can be given than that which refers them to the special endowments of the *cells*, the real instruments in the process. That the particular modification of structure which the organ may present, has no essential connexion with the character of the secretion, is evident, from the fact that almost every gland may be found under a variety of forms in different parts of the animal series; and for every gland there is a part of the animal scale below which it does not exist, and when it makes its first appearance it almost always presents a character nearly as simple, as that of the least complex glandular structures in the higher orders.

The *simplest form of secreting organ* is that of the simple *animal membrane*, well supplied with blood-vessels and covered with an epithelium; of such a membrane we have an example in the serous and synovial membranes. The next is that of the *follicle*, a depression or inversion of the animal membrane, lined with epithelium-cells, and abundantly supplied with blood-vessels, from which are elaborated their peculiar secretions. The *third* and *last* form of secreting organs is the *gland*, which is nothing but an aggregation of follicles, closely packed together, so as to present a large secreting surface in as small a bulk as possible. In some glands the sacs or follicles are prolonged into cæca or blind tubes, as in the kidney and testis; these are called *tubular glands;* or else they are very greatly multiplied, and clustered together (like currants on a stalk) upon efferent ducts common to several of them. (Fig. 190.)

Fig. 190.

In all secreting organs the important agents are the *cells*, which are developed upon the lining membrane of the follicles and tubes, and which select and elaborate the materials from the blood, and discharge their contents into the excretory duct. These cells are being constantly cast off and replaced by a new growth, having their origin in the basement-membrane of the mucous membrane which lines the ducts or follicles.

The simplest condition of a secreting cell in the animal body is that of the adipose tissue, every cell of which has the power of selecting its materials from the blood. The contents of these, however, are not discharged, but remained stored as a reservoir in time of need. The *adipose tissue* has already been described.

There is a difference between the processes of *secretion* and *exhalation:* the former is a *vital* process. The latter a *physical.* Wherever a fluid requires to be elaborated, it is done by a process of secretion,

and the agents are *cells;* but where no such process is necessary, the fluid pre-existing in the blood, it soaks out by the physical process of exosmose.

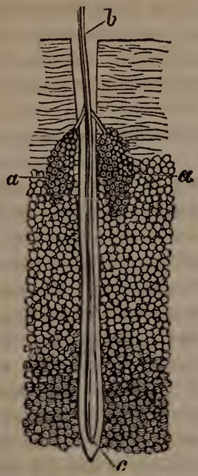
The *exhalations* do not require much notice after what has been said of their mode of separation. Under this head are included those from *serous* and *synovial membranes*, which are destined to lubricate them; the fluid of the *areolar tissue*, giving softness and suppleness to that tissue; the watery exhalations from the *skin* and *mucous membranes*, a mere physical evaporation; and the exhalation of the *aqueous* and *vitreous* humours of the eye, two of its transmitting and refracting media.

The *follicular secretions* are divided into two classes,—the *mucous* and *cutaneous.* In the first division, besides the ordinary follicles which secrete the lubricating mucus, and which are seen generally existing in mucous membranes, there are included the numerous glandulæ of the intestinal canal. In the *stomach* are the simple and compound *gastric follicles*, opening into little pits or depressions in the mucous membrane; these follicles secrete the *gastric juice.* In the *duodenum* are the *glands of Brunner*, seated in the *submucous* tissue; these consist of numerous minute lobules, with a common excretory duct. The nature of their secretion is unknown. In the *jejunum* and more particularly in the *ileum*, are the agminated *glands of Peyer*, which consist of a cavity covered over with an extremely thin membrane, and having no excretory duct; their secretion probably escapes through the medium of cells developed in this membrane. These glands or follicles are supposed to secrete the putrescent elements of the fæces. Throughout the whole intestinal tract, especially in the small intestines, are found the follicles of Lieberkuhn, which secrete the thick, tenacious mucus to lubricate these parts. In the cæcum and lower part of the rectum, are a number of simple and large follicles, producing slight elevations on the surface of the mucous membranes. These are always most abundant where most mucus is required. The glands of Davergny and Nabothi, in the vagina and cervix uteri, are also lubricating mucous follicles; as are also the glands of Cowper, and the prostate in the male. The *tonsil glands* are considered by some anatomists and physiologists as composed of numerous mucous follicles having the same function, viz., to lubricate the parts on which they are placed.

The *cutaneous follicular secretions* include the *meibomian*, *ceruminous*, *sebaceous*, and *sudoriferous.* The *meibomian follicles* are seated in the substance of the tarsal cartilage, and secrete a gummy fluid to lubricate the edges of the lids. The *ceruminous*, are seated beneath the skin of the auditory meatus, and consist of a tube convoluted upon itself. They secrete a resinous substance, nearly solid, and intended to lubricate the external meatus. The *sebaceous* matter of the skin is secreted by innumerable minute, branched follicles, opening by a narrow orifice. These sebaceous glands generally open into

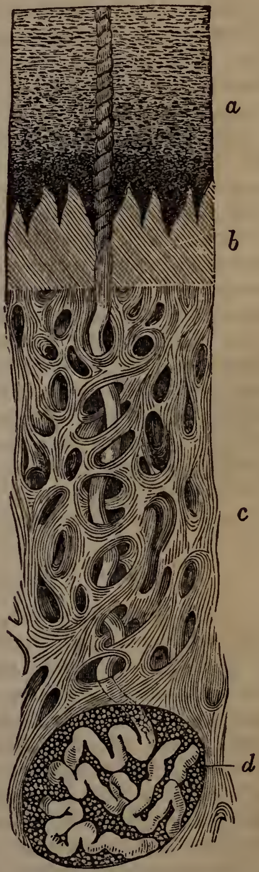
the follicles of the hairs. By these an adipous secretion is poured out upon the skin, destined to protect it from the action of the sun and air.

Fig. 191.



a a. Sebaceous follicles. *b.* A hair, with its follicle *c*, surrounded by fat-cells.

Fig. 192.



a. Epidermis. *b.* Upper layer of cutis vera. *c.* Cutis vera. *d.* Sweat-gland surrounded by fat-cells, with its duct running spirally through the layers of the skin.

They are sometimes the seat of a minute parasite, called the *demodex folliculorum.*

The *Perspiration* is formed by small tubes of peculiar conformation, very much convoluted, and seated just beneath the cutis vera, and pouring out their secretion by minute pores upon the epidermis. The ducts pass through the epidermis and cutis vera in a spiral direction, and their openings upon the epidermis, which are seen along the elevated lines of the skin of the palm and sole, are called *pores.* (Fig. 192.) According to Mr. E. Wilson, the number of these sweat-glands in the whole surface of the body is about *seven millions,* and the conjoined length of the perspiratory tube 28 *miles.*

The secretion from these glands is continually taking place, but as it is usually evaporated as fast as it is formed it does not become *sensible.* If, however, from excessive secretion, or a moist condition of the atmosphere, it is not carried off as fast as formed, it accumulates

upon the surface, constituting the *sensible* perspiration. It has usually an acid reaction, which is due to the presence either of acetic or lactic acid. It contains also a small amount of animal matter, and some salts, principally *chlorides.*

The entire amount of fluid insensibly lost from the cutaneous and pulmonary surface is estimated at 18 grs. per minute; of these 11 pass off by the skin, the remainder by the lungs. The maximum loss from both sources during 24 hours is equal to about 5 lbs., the minimum 1⅝ lbs.

The perspiratory secretion is *depuratory,* and vicarious with that of the kidney, both separating the superfluous azotized matters. The amount of solid matter thrown off from the skin in 24 hours is about 100 grains. The amount of fluid thrown off is influenced greatly by external temperature, being greatest when it is elevated, the object of which increase is to keep down the temperature of the body by *evaporation.* It is also influenced by general conditions of the vascular and nervous system, though the manner is not yet well understood.

A peculiar glandule, resembling the sudoriferous, but larger, has lately been described as existing in the axillæ; these are called the *odoriferous* or *miliary,* and probably serve to secrete the characteristic odour of those parts. The odorous principle may be detected in blood which has been dried, by treating it with sulphuric acid; and it is said to differ so much in different animals as to afford a test by which their blood can be recognised. It has even been said that the blood of the female can by this means be distinguished from that of the male.

GLANDULAR SECRETIONS.

The *lachrymal secretion* is formed by the gland of that name, whose seat and structure are described in the *anatomical* division. It is one of the *granular* glands, and pours its secretion upon the surface of the conjunctiva to cleanse and lubricate. The lachrymal fluid resembles dilute serum deprived of a great part of its albumen. It is a constant secretion, and is absorbed by the open orifices of the nasal ducts, and carried into the nose as fast as it is poured out. The cause of this absorption is probably capillary attraction, assisted by the syphon-like action of the nasal duct. This secretion is greatly influenced by the emotions.

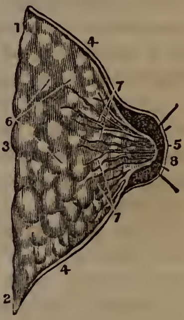
The *salivary secretion* is formed by the *Parotids, Submaxillaries, Sublinguals,* and *Pancreas;* the latter is sometimes called the *abdominal* salivary gland. These glands also come under the division of the granular glands, being composed of aggregated follicles, discharging into an excretory duct.

The salivary secretion is not necessarily constant; it takes place during the movements of mastication, and when any irritant is taken into the mouth. It is alkaline in its reaction, and contains among other ingredients, a peculiar animal principle, analogous to pepsine,

called *ptyaline,* which seems to act as a ferment, since by it starch may be converted into sugar, and sugar into lactic acid. A considerable proportion of saline and earthy matter exists in the solid residue of the saliva; this is nearly the same as that which the blood contains. The tartar of the teeth consists principally of one of these, the earthy phosphates, held together by a little animal matter. If the alkalinity of the saliva be destroyed, it loses its converting power on starch. The specific gravity varies from 1·006 to 1·009. The *quantity* secreted during 24 hours has been estimated at about 15 or 20 ounces. The *pancreatic secretion* contains a larger proportion of solid matter than the saliva.

The Mammary Secretion is peculiar to the *mammalia,* and is one of those which are destined for special uses in the economy. The *gland* is found in both sexes, and presents but little difference in them till the period of puberty. It consists of numerous lobules, held together by areolar tissue. Each lobule consists of a series of ducts passing inwards from their termination to the nipple, and then ramifying like the roots of a tree, their ultimate subdivisions terminating in minute follicles. The mammillary tubes are ten or twelve in number; they are straight ducts terminating in the nipple, and having a slight dilatation just before their termination, which acts as a reservoir to receive the secreted milk. The secretion, as in the other glands, takes place in the ultimate follicles, by means of cells, which discharge themselves into the ducts. (Fig. 193.)

Fig. 193.



A vertical section of the Mammary Gland, showing its thickness and the origins of the lactiferous ducts; 1, 2, 3, its pectoral surface; 4, section of the skin on the surface of the gland; 5, the thin skin covering the nipple; 6, the lobules and lobes composing the gland; 7, the lactiferous tubes coming from the lobules; 8, the same tubes collected in the nipple.

The mammary gland of the male is a miniature of that of the female, but it does not undergo any marked increase in size at any particular period, its evolution going on *pari passu* with that of the body. There are some instances on record of its secreting milk; the secretion being induced, in one case, by the individual applying the children entrusted to his care, to the breasts during the night.

The milk consists of water holding in solution sugar, various salin ingredients, and a peculiar albuminous substance called *caseine,* and having oleaginous particles suspended in it. By allowing the milk to stand, the oil-globules will come to the top, constituting the *cream;* this includes also a considerable amount of caseine, with the sugar and salts of the milk. By agitating the cream the envelopes of the oil-globules are ruptured, and it is separated into *butter* and *buttermilk,* the latter containing the *caseine, sugar,* &c. A small quantity

of caseine, however, is generally entangled with the butter, which has a tendency to render it rancid, and should be removed by heat.

After the removal of the cream the milk still contains the greatest part of the caseine and sugar; if kept long enough, the sugar is converted into *lactic acid*, which coagulates the caseine, precipitating it in small flakes. The same precipitation may be accomplished by other acids; the most effectual is that contained in the *rennet*, or dried calf's stomach, the active principle of which will coagulate 30,000 times its weight of milk. The sugar may be obtained by evaporating the whey.

The proportion of the solid ingredients of the milk is about 110 parts in 1000, varying according to constitution, the amount and character of ingesta, and the time which has elapsed since parturition.

The first milk is called the *Protogala*, or *Colostrum*, and has a purgative effect upon the child, owing to the presence in it of numerous yellow granulated corpuscles, called colostrum corpuscles. This property soon disappears, however, though occasionally it returns after the expiration of twelve months, seeming to indicate that the flow should be no longer encouraged.

Human milk contains more sugar and less caseine than that of the cow, a fact to be remembered in substituting the latter for the former. The milk of carnivorous animals, fed exclusively on animal diet, contains scarcely a trace of sugar, while the caseine and butter are abundant.

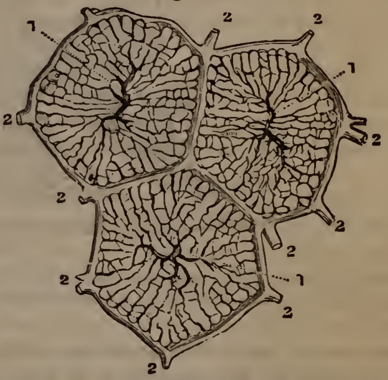
The quantity of milk that can be squeezed from either breast at one time is about two ounces. It is not always the largest breasts that secrete most milk, since their great size is often owing to the presence of adipose matter. The secretion is often materially affected by emotions, &c., so as to become poisonous to the child; and it is often rendered medicinal by substances administered to the mother.

The instances of vicarious secretion of milk are not numerous; and in no instance is there any proof that the elements of the fluid were pre-existent in the blood. The secretion sometimes occurs in undoubted virgins, widows, and women past the child-bearing period, as well as in males.

Secretion of Bile. — The *Liver* is perhaps more universally present throughout the animal scale than any other gland. It is the largest gland in the body, weighing from three to four pounds. The entire organ is made up of a vast number of minute *lobules*, of irregular form, of about the average size of a millet-seed. Each of these lobules is a miniature gland, containing all the component elements of which the gland is made up, viz.: branches of the hepatic artery and vein, branches of the portal vein, branches of the hepatic ducts and secreting cells. These lobules are connected together by means of areolar tissue and anastomoses of blood-vessels. The *hepatic artery* is distributed in a capillary form upon the walls of the hepatic ducts, and upon the trunks and branches of the portal and hepatic veins; it

is therefore probably destined for the nutrition of the organ, and not to supply materials for the biliary secretion, at least until it has become venous, by traversing the capillary system. From the capillary network the blood passes into branches of the portal vein, and thence into the hepatic veins; for when a fine injection was thrown by Mr. Kiernan into the hepatic artery, the portal veins became filled, but not the hepatic. The *vena portæ* ramifies in a capillary form *between* the lobules, and hence is called the *interlobular vein,* sending capillary twigs inwards, which converge towards the centre of the lobule, to form the *hepatic* or *intralobular vein.* (Fig. 194.) These latter terminate in the larger trunks, which pass along the bases of the lobules, collecting from them their venous blood; these are called by Mr. Kiernan *sublobular veins.* The main trunk of the hepatic vein terminates in the ascending vena cava. The *hepatic ducts* also form a plexus, which surrounds the lobules, connecting them together, but not sending branches towards their interior, as commonly supposed. Their mode of termination, and their relation to the *hepatic cells* forming the parenchyma of the gland, are as yet unexplained. These *cells* of the liver, which are the real agents in the secreting process, are of a flattened spheroidal form, lying in piles, which seem to be directed from the circumference to the centre of each lobule. Their diameter is from 1-1500th to 1-2000th of an inch; they have a distinct nucleus, and a well-marked biliary tinge, and contain a granular amorphous matter with a few small adipose granules. They are easily obtained in a separate condition by scraping a piece of fresh liver.

Fig. 194.



Horizontal section of three superficial lobules, showing the two principal systems of blood-vessels; 1, 1, intra-lobular veins, proceeding from the hepatic veins; 2, 2, interlobular plexus, formed by branches of the portal veins.

The secretion of bile is probably a constant operation, although it may vary in quantity at different times. It may be discharged at once into the intestine, or it may regurgitate into the gall-bladder, as it probably does when the intestine is empty and there is no stimulus there to provoke the flow. In the gall-bladder the bile undergoes a concentration by the absorption of its watery parts; it is also mixed with the mucus secreted from its walls.

The chemical composition of the bile is unsettled. It is of a yellowish-green colour, viscid, and slightly bitter. It combines readily

Fig. 195.

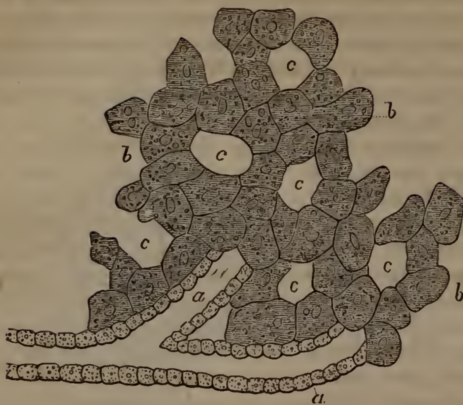


Diagram of the arrangement of the cellular parenchyma (*bb*) of the *Human Liver*, with reference to the radicles of the interlobular ducts (*aa*), and the vascular spaces (*cc*).

with water, mixes freely with oil or fat, and foams, when stirred, like soapy water. The proportion of solid matter is usually from 9 to 12 per cent.; nearly the whole of this consists of substances peculiar to the bile.

Three distinct substances are found in the biliary matter:—*Cholesterine*, or bile-fat, resembling spermaceti, and consisting principally of carbon and hydrogen; *bilic acid*, a compound of soda with a peculiar organic body, now regarded in the light of a fatty acid, and described by some chemists as choleic acid, bilin, picromel, &c.; and a colouring matter called *biliverdin*, a substance identical with the chlorophyll of plants. In addition to these, the bile contains some earthy salts.

Uses of the Bile.—A portion unquestionably passes off with the fæces; this, which includes the colouring matter, is that which would be injurious if retained in the blood, and is probably *excrementitious.* The *soapy portion* seems to act by rendering the fatty matters soluble, and thus enabling them to be absorbed by the lacteals. The importance of the bile has been shown by Schwann, who prevented it from passing into the intestine, and found that the animals wasted, and at last died in a state of great emaciation. The secretion of bile is not the only function performed by the liver; for the experiments of Mr. Bernard have shown that the peculiar sugar which is found in the blood of the hepatic vein, and which may be extracted from the substance of the liver itself, may be generated at the expense of proteinaceous compounds by this organ; and the same is true of the *liver-fat*, the production of which seems to be vicarious with that of sugar. These substances are as much the product of secretion as the bile

itself; although they are carried off by the hepatic vein and are directly eliminated by the lungs. Besides its function as an assimilating organ, therefore, the liver exerts its secretive action in separating the hydrocarbonaceous portion of the protein-compounds which are destined to undergo retrograde metamorphosis as being either *superfluous* or *effete;* and these under the three forms of Sugar, Fat, and Bile.

The *sources* of the bile may be found in the disintegration of the *fibrinous* and *nervous* tissues when the amount of food is just sufficient to supply the waste of the system, the liver removing such products as are rich in carbon and hydrogen; and in any excess in the non-azotised compounds derived from the food, beyond the amount that is requisite for the supply of the respiratory process, or that can be deposited as fat. In this elimination of hydro-carbon the liver is subsidiary to the lungs. In the fœtus it is the great decarbonizing agent.

In regard to the *kind of blood* from which the bile is secreted, analogy would point to the hepatic artery, although the experiments of Kiernan seem to fix it upon that of the vena portæ. Both have their supporters. Those who embrace the supposition of the secretion from the *hepatic artery*, assign to the vena portæ the office of mixing thoroughly with the blood heterogeneous substances absorbed from the stomach and intestines, before transmitting them to the heart. Those who contend for the secretion from the vena portæ assign to the hepatic artery the office of nourishing the liver, which from its small size, in comparison with the vena portæ, seems more justly to be its function.

SECRETION OF URINE.—This secretion is purely *excrementitial*, being destined to remove certain effete substances from the blood, whose retention would be positively injurious. As it is the function of the liver to remove the superfluous carbon, so it is of the kidney to get rid of the excess of nitrogen in the blood.

The kidney is a *tubular* gland, being formed of uriniferous tubes, both convoluted and straight, the convoluted being found in the cortical portion, the straight in the medullary. The cortical portion is the most vascular, and it is probably the seat of the greater part of the secreting process, whilst the medullary is concerned in carrying the secreted matter; the two parts being in this respect analogous to the cortical and medullary portions of the brain.

In the cortical portion of the kidney are seen a number of small dark points, called Corpora Malpighiana; each of these is composed of a mass of minute blood-vessels very much convoluted upon themselves, like a ball of twine, into which a small afferent branch of the renal artery is seen to enter, and an efferent venous twig to emerge, the points of immergence and emergence being very near to each other. Each of these Malpighian corpuscles is included in a flask-like expansion of one of the tubuli uriniferi, which is dilated to receive it. It is at *this* point, and from the *arterial blood* of the corpuscle, that the *watery* parts of the urine are separated by soaking

through the walls of the blood-vessels and tubes, the blood being detained in the corpuscles for this purpose.

Fig. 196.

Distribution of the renal vessels; from kidney of horse; *a*, branch of renal artery; *af*, afferent vessel; *m*, *m*, Malpighian tufts; *ef*, *ef*, efferent vessels; *p*, vascular plexus surrounding the tube: *st*, straight tube; *ct*, convoluted tube. Magnified about 30 diameters.

The *venous twig* after leaving the corpuscle of Malpighi, becomes again capillary, and interlaces with the uriniferous tubes at another point; and at *this* point, and from *venous* blood, as in the vena portæ, the *solid* matters of the urine are separated by the agency of *cells* developed in the walls of the tube. (Fig. 196.)

It would thus seem that the function of the Malpighian corpuscles is to get rid of the superfluous water in the blood, which, from their peculiar arrangement, they are well calculated to do. In this respect they assist the skin, which is very liable to great variations in the amount of fluid it exhales in accordance with the temperature of the air around.

The quantity of *solid* matter eliminated by the kidney has no reference to the amount of water to be got rid of; being dependent upon the amount of *waste* in the system, and upon the quantity of surplus azotised aliment which has to be discharged through this channel.

The average quantity of urine voided in twenty-four hours, by adults who do not drink more than the wants of nature require, is from 30 to 40 oz. Its average specific gravity is 1020. The amount voided is less in summer than in winter, on account of the large exhalations from the skin in the former season. The quantity of *solid matter* varies in health from 3 6 to 6·7 per cent. About one-third of the solid matter is made up of alkaline and earthy salts; the rest consists of organic compounds.

The urine in health usually presents an *acid* reaction; this depends, however, upon certain conditions furnished by the aliment, and may be altered by a change in the ingesta.

The most important constituent of the solid matters is *urea*, a transparent crystalline substance, soluble in water, and combining with acids without neutralising them. In chemical composition it is identical with cyanate of ammonia, viz.: 2 carb., 2 ox., 2 nit., 4 hyd. The amount of urea excreted may serve as a measure of the *waste* of the system, especially of the muscular system. The average amount of urea is about 30 parts in 1000 of urine. The amount excreted by children is much greater in proportion to their bulk than in old men. This corresponds precisely with the rapidity of interstitial change at different periods of life.

Uric or *lithic* acid is another important ingredient. It exists in

larger proportions in the urine of the lower vertebrata than in mammalia, in whom there exists only about one part in a thousand of urine. It is crystallizable, tasteless, inodorous, and nearly insoluble in water. It exists in healthy urine in combination with a base, either ammonia or soda, which latter, according to Liebig, is derived from the bibasic phosphate of soda, which by yielding up a part of its base gives the acid reaction to the urine that characterizes its healthy state. Its affinity for the base, however, is so feeble, that it is readily thrown down by any other acid in the urine. According to Keller, uric acid is not replaced by *Hippuric* in the urine on the administration of Benzoic acid. The amount of uric acid is not dependent on *waste* or diet, but frequently on disease, as gout, in which it is often deposited from the blood, in combination with soda, around the affected joints, forming *chalky concretions.* The *urates* are commonly *red.* The presence of *lactic acid* as a constituent of healthy urine is denied by Liebig.

The urine contains also various saline matters, such as muriates, sulphates, and phosphates; the latter supposed to be derived from the waste of the nervous tissue, into whose composition phosphorus enters. The phosphates are commonly yellowish white in colour. The quantity of salts in the urine is never the same in the same individual in like spaces of time; the urine of men, however, generally contains a relatively larger portion of salts than that of women.

The total suspension of the urinary secretion is attended with rapidly-fatal results, the patient dying with symptoms resembling those of narcotic poisoning.

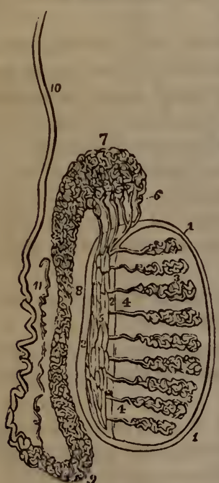
Besides the essential constituents already mentioned, the urine often contains accidentally-mixed substances, such as articles of food, of drink, or of medicine, which pass into it unchanged or changed, and can sometimes be detected in it in an inconceivably short time after administration.

This apparent mystery has been explained by M. Bernard, who has demonstrated that there is a direct communication between the vena portæ of the horse (which, it will be remembered, receives the products of absorption from the stomach) and the inferior cava, distinct from the communication that exists between the portal and hepatic veins in the liver. During digestion, when the portal system is gorged with blood, a portion of it passes through these collateral branches into the vena cava, thereby greatly facilitating the flow of the remainder through the portal vein. That portion of blood that has been carried into the vena cava ascendens is forced downwards towards the kidneys by a set of muscular fibres in the walls of this venous trunk, commencing at the diaphragm and extending down as far as the renal veins. When these fibres contract, the blood cannot pass upwards to the heart, because the right cavities of that organ are already gorged with supplies from other sources; it must, therefore, descend. It is prevented from passing into the iliac and crural veins by a valve at the

opening of the renal veins, which shuts down under the downward current, and thus the blood is compelled to enter the renal veins, which, as well as the inferior cava, can be seen to pulsate under the muscular contraction. Thus it is that many substances absorbed from the stomach during digestion reach the portal system, and pass from thence to the vena cava and *renal veins* without going the round of the circulation. In this way is explained the frequent innocuousness of poisonous agents administered during digestion. During digestion there is no circulation in the kidney, the blood being carried into it by both arteries and veins; the urine therefore will vary with the food that is taken, being acid after eating animal food, and alkaline, after a vegetable diet.

During the time that the stagnation and downward current are taking place in the vena cava ascendens, the blood from the lower extremities reaches the heart through the *vena azygos*, which has been shown to be equal to the duty of establishing the collateral circulation in cases of obstruction of the vena cava by tumours. Whether such an arrangement exists in man remains yet to be proved.

Fig. 197.



A view of the minute structure of the testis; 1, 1, tunica albuginea; 2, 2, corpus highmorianum; 3, 3, tubuli seminiferi convoluted into lobules; 4, vasa recta; 5, rete testis; 6, vasa efferentia; 7, coni vasculosi constituting the globus major of the epididymis; 8, body of the epididymis; 9, its globus minor; 10, vas deferens; 11, vasculum aberrans or blind duct.

The SPERMATIC SECRETION is formed by the testis, another *tubular* gland consisting of lobules formed of convoluted seminiferous tubes. The number of lobules is about 450 in each testis, and that of tubules about 840. The different parts may be seen in Fig. 197. The diameter of the tubes is generally very uniform; they anastomose freely with each other, without increasing in size. The testes originate in the lower part of the corpora woolfiana, in the embryo, while the kidneys spring from the upper and outer parts. They begin to descend into the scrotum about the middle of pregnancy; at the seventh month they reach the inner ring; in the eighth they enter the passage; and in the ninth they descend into the scrotum. Sometimes one or both remain in the abdomen, without, however, interfering with their function.

The sperm is a thick, tenacious, grayish fluid, having a peculiar odour called *spermatic*, probably dependent on the secretions mixed with it. It is difficult to analyze it, in consequence of its admixture with the secretions of the prostate and Cowper's glands. It is alkaline in its reaction, and contains albumen and a peculiar principle called *spermatin*. The so-called

spermatozoa are developed in the interior of the spermatic cells, and are set free by their rupture before they leave the tubuli of the testis. They are supposed to correspond with the pollen-tubes of plants, and are probably the agents by which the fecundating materials of the male are brought into contact with the elements supplied by the female. They seem to be essential to the reproductive process. The sperm also contains *seminal granules*, the mode of production of which corresponds with that of other glands. The salts that are found in the sperm are muriates and phosphates, especially the latter. The secretion takes place about the 14th or 15th year, and continues till about 60 or 65; and during the whole of this time is much under the influence of the nervous system.

The *Spleen*, *Thymus*, and *Thyroid glands*, and *Supra-renal Capsules*, are called *Glandiform Ganglia*, sometimes *Vascular Glands*. They all act as diverticula to the circulation in their neighbourhood; the spleen to the portal circulation, the thymus to the lungs in fœtal life, the thyroid to the cerebral circulation, and the supra-renal capsules to the kidney. They all seem to share likewise in the preparation of the nutritive materials of the blood, assisting in this respect the lymphatic system, to which they seem to be appendages.

CALORIFICATION

Is that function by which the *heat* of organized beings is generated. The *source* of this heat has long been a disputed question among physiologists. From the fact that plants are capable of generating an amount of heat, sometimes far above that of the surrounding medium, an unequivocal indication is given that we are to look for its source in the organic functions and not in those of animal life. In examining the phenomena in plants which bear any relation to this source, we at once perceive that an absorption of oxygen and extrication of carbonic acid are continually taking place (constituting the respiration of plants), and that these processes occur with great activity at the time when the evolution of heat is most remarkable,—that of germination and flowering.

In animals, an approximation may be perceived between the amount of oxygen consumed and of carbonic acid given off, and the amount of heat liberated. Some physiologists have thought that this carbonic acid was formed in the lungs, and the resulting heat distributed to the system by the arterial vessels, they having a greater capacity for heat than the veins; but it has already been shown that the carbonic acid is formed in the tissues and not in the lungs; as the latter, therefore, cannot be the point at which the heat is generated, it must be evolved throughout the system. Exercise, or any increase in the nutritive operations of a part, is always attended with an elevation of temperature, as well as an increase in the extrication of carbonic acid.

The formation of carbonic acid by the union of the oxygen absorbed from the air with the carbon set free from the body, is the main source

of the heat generated within the animal system. The amount of carbon consumed in 24 hours is not sufficient, however, to account for *all* the heat liberated; we must therefore look to other sources. That it is not *dependent* on nervous influence is evident from the fact that the process occurs in vegetables. Perhaps the formation of the various secretions,—fluids having a less capacity for heat than arterial blood, —may be accompanied with the elimination of some latent heat. It is also suggested that the union of oxygen with hydrogen, phosphorus and sulphur, and the conversion of the plastic fluids into solids, may likewise explain the source of some of the heat that is unaccounted for.

That the *cutaneous respiration* is subservient to the maintenance of the heat is evident from the fact that if the hair of rabbits be shaved off, and the surface covered with varnish, the temperature instantly falls.

Diseases that involve an accelerated pulse and augmented respiration are generally accompanied with elevation of the temperature. The converse is also true. The ordinary temperature of the human body ranges from 98° to 100° Fahr., varying but a few degrees above or below when the temperature of the surrounding medium is elevated or depressed.

Man is able to resist high degrees of temperature (provided the surrounding air be dry), by the evaporation of the perspiratory secretion from the surface of his body. The less the age of the individual, the less is his ability to maintain an independent temperature; the human infant in this respect resembles a cold-blooded animal.

ANIMAL FUNCTIONS, OR FUNCTIONS OF RELATION.

The *Animal* functions are so called because they are peculiar to that class of organized beings. They render the individual conscious of external impressions, and capable of executing spontaneous movements, and are dependent for their exercise on the existence of a nervous system. They are thus classified:

1st. *Sensation.*
2d. *Muscular Motion.*
3d. *Mental Manifestation.*

It has been shown (pages 240–241) that into the composition of the nervous structure two distinct kinds of matter enter, viz.: the *gray* or *vesicular*, and the *white* or *tubular;* that these two kinds differ not only in structure and colour, but also in *function*, the *gray*, or *vesicular*, being a generator of nervous influence, and the *white* the carrier of this influence to the various parts of the body. A union of these two kinds of matter constitutes a *ganglion*, or *nervous centre.*

Our fundamental idea of a nervous system consists of a *ganglion*,

or *centre,* thus composed, and a set of trunks composed of the *white* or *tubular* matter, connecting the central organ with the different parts of the fabric. These trunks or branches are distributed to the *sensory surfaces* or *organs,* and to the *muscles* or *motor organs.* The *first* receive and convey impressions *from* the periphery *to* the centre, and are hence called *afferent.* The latter convey *motor* influence *from* the centre *to* the periphery, and are hence called *efferent.* The first are sometimes called *sensory,* from their connexion with *sensation;* the latter are likewise sometimes designated *motory,* from their connexion with muscular contraction.

The *functional activity* of the nervous system is mainly dependent upon the due supply of oxygenated blood; this is especially necessary at the points at which changes *originate,* not seeming so necessary for the mere conduction of impressions. In accordance with this, we find the *centres* and the peripheral extremities of *afferent* nerves always duly supplied with *arterial blood;* any interruption to its supply being attended with an immediate arrest of their functions. On the other hand, any *increase* in the supply of a part is attended with an exaltation of its function, as is seen in *active congestion* of the brain and spinal cord. It is now a generally-received physiological truth, that the functional activity of the nervous system is mainly dependent, not only upon the due supply of arterial blood, but also upon the *combination of its oxygen with the elements of the nervous structure.*

For physiological consideration the nervous system may be divided into *three* great divisions, the *Cerebro-spinal;* the *Reflex,* or *true spinal;* and the *Great Sympathetic.*

The *Cerebro-spinal* includes the cerebrum and cerebellum, with the *sentient* and *motor nerves* that run to and proceed from them along the base of the brain, or along the spinal marrow, to every part of the system. It presides over *sensation* and *voluntary motion.*

The *Reflex,* or *true spinal,* includes the *gray matter* of the *medulla oblongata* and *spinalis* as its *centre,* and a peculiar set of fibres running to and proceeding from these centres, called *afferent* or *excitor,* and *efferent* or *motor.* It presides over *involuntary* or *excited movements.*

The *Great Sympathetic,* or *ganglionic,* consists of a series of ganglia on each side of the vertebral column, extending from the base of the cranium to the os coccygis, and communicating both with the spinal and encephalic nerves, sending its branches along the arteries and particularly to the organs of the nutritive functions. Its office is supposed to be to bring the functions of organic life into relation or sympathy with those of animal life.

The changes which take place in a nerve of any of the above divisions, when it is in action, are known to us only by the effects they produce on the sentient mind, or on muscular parts. There is no alteration in the physical appearance of the nerve or its fibres, which can

be detected by our aided or unaided vision, and yet, from the instantaneous effect produced by stimuli, and its as sudden cessation on their withdrawal, we can refer the phenomena to nothing so readily as to a *molecular change*, rapidly propagated along the course of a nerve from the point of application of the stimulus. According to Bowman, a *state of polarity* is induced in the particles of the nerve by the action of the stimulus, which is capable of exciting an analogous change in other particles, whether muscular or nervous; whence results the peculiar effects of the nerve's influence. If this doctrine be tenable, the inference results that the nerves are not mere *passive* conductors, but that the whole extent of the fibre between the stimulated point and the peripheral extremity, or central termination, is the seat of change.

The organic changes produced in a nerve by either *mental* or *physical* stimuli, develope that remarkable power known as the *nervous force*, or *vis nervosa*. Of the nature of this power we know nothing. That it is not *identical* with electricity or galvanism, as was once supposed, is now established. The following experiments prove this. If a ligature be placed upon a nerve, its power of conducting nervous influence is lost, while it still continues to transmit electrical currents. Again, if a section of a nerve be removed, and its place be supplied by an electric conductor, electricity will still pass along the nerve, but no nervous force will be propagated through the conductor to the parts beyond. Lastly, the conducting power of nerve for electricity, according to Matteucci, is not more than one-fourth that of muscle; hence, if the nervous force were electric, it would leave the nerve, and follow the muscle in preference. It seems to be a peculiar power developed in the nervous structure under the influence of appropriate stimuli; just as *contractility* is developed in a muscle, under similar influence.

Notwithstanding then, the great analogy that exists between the nervous power and electricity, we are not warranted in regarding them as identical; their true relation will be best expressed by saying that they are so closely "*correlated*" that each may be the means of exciting the other. For instance, when a current of electricity is sent along a motor nerve for a short distance only, it will excite contraction in the muscles to which it is distributed; when along a sensory nerve, it will excite in the sensorium the peculiar sensations to which that nerve ministers. So on the other hand, the nervous force is capable of generating electricity, as is seen in the case of electrical fishes. These "*forces*" therefore would seem to bear the same relation to each other as Mechanical Motion, Heat, Light, Electricity, Magnetism, and Chemical affinity, which although regarded as *distinct forces*, are fast coming to be considered as mutually convertible; so that one force (A) operating upon a certain form of matter ceases to manifest itself, but developes another (B) in its stead; which latter (B) may be reconverted into the first (A) or into some other (C) which may reproduce

(A or B) or some other (D or E). Thus motion suddenly arrested produces heat; Heat applied to two dissimilar metals produces electricity; Electricity again may develope motion or chemical affinity or light. It is in this way that "forces" are said to be "*correlated*" or mutually convertible.

The functions of particular nerves may be discovered by examining their anatomical distribution. If a nerve is discovered to lose itself entirely in the substance of *muscles*, it may be inferred to be chiefly or entirely *motor* or *efferent*. If, on the contrary, it can be traced to a membranous expansion, *cutaneous*, *mucous*, or otherwise, there is equal reason to believe it an *afferent*, or *sensory* nerve. If a nerve is *entirely* distributed upon a surface adapted to receive impressions of a *special* kind, it may be inferred that it is incapable of receiving or transmitting any others. Such a nerve is said to be one of *special sensibility*, to distinguish it from those that transmit impressions of a general character, and which are called nerves of *general sensibility*.

In considering the functions of the various parts of the nervous system, it is best to begin with the *spinal marrow*, which, with its cranial prolongation, the *medulla oblongata*, may be regarded as the essential part of the *nervous system of vertebrata*.

OF THE MEDULLA SPINALIS.

The *Spinal cord* is to be considered in a twofold light. *First.* As a conveyer of nervous agency *to* and *from* the brain. *Second.* As an *originator* of nervous influence. All the cerebral nerves are subject to the influence of the brain, and all the *spinal* nerves are subject to the same influence through the medium of the spinal cord. As soon as the transmission of this influence is interrupted by division or wounds inflicted upon the cord, impressions on sensitive nerves cease to be propagated to the sensorium, and the brain loses the power of *voluntarily* exciting the action of the *motor* nerves which are given off below the injured point. All the nerves *above* this point, however, still transmit impressions, and are subject to the influence of the brain.

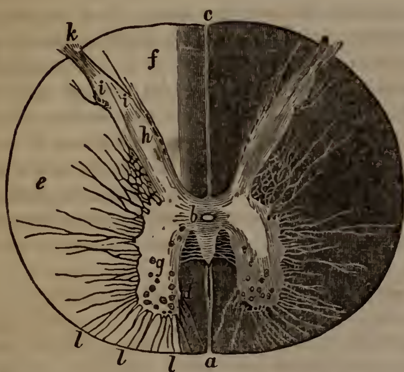
The *white fibrous* matter of the cord is not to be regarded as the common trunk of all the nerves of the body. For although many of the fibres of the roots of the spinal nerves become continuous with the longitudinal fibres that form the white strands of the spinal cord, it is by no means certain on that account that they pass on to the brain, the chief part of the longitudinal strands of the cord being apparently made up of commissural fibres, which form an intimate connexion between its different segments, as in insects. It is easily seen that if the white matter of the spinal cord was directly continuous between the roots of spinal nerves and the brain, the diameter of the cord ought to increase as we approach the cervical region.

The spinal cord is traversed by an anterior and a posterior fissure,

dividing it into *two lateral halves*, each of these also is marked by two furrows on each side, subdividing it into *three* columns. There are, therefore, upon each half of the cord, an *anterior; middle*, or *lateral;* and *posterior* column. Each spinal nerve arises by two roots, an *anterior* and a *posterior*. The anterior root joins the spinal cord near the *anterior* furrow, and the posterior near the *posterior* furrow. (Fig. 198.)

The functions of these two roots are now established. The posterior, which is distinguished by having a ganglion upon it, is the afferent root. Part of its fibres run on to the brain, conveying impressions to that organ; part terminate in the gray matter of the spinal cord, in like manner conveying impressions to the latter. In a word, the posterior root is the *sensory* and *excitory root*.

Fig. 198.



Transverse section of human spinal cord, close to the third and fourth cervical nerves. *f.* Posterior columns. *i, i.* Gelatinous substance of the posterior horn. *k.* Posterior root. *l.* Supposed anterior root. *a.* Anterior fissure, *c.* Posterior fissure. *g.* Anterior horn of gray matter. *e.* Antero-lateral column (from *k* to *a.*)

The *anterior* is the *efferent* or *motor root.* Part of its fibres come from the brain, conveying voluntary motion; part have their origin in the gray matter of the spinal cord, and are conveyers of *excited* motion from that centre. Those fibres of both roots which are unconnected with the brain, constitute the system to which reflex actions are due, and, with the gray matter of the spinal cord, constitute *a distinct nervous circle.* Part of the afferent or excitor fibres, after traversing the *gray* substance, pass out on the same side as the efferent or motor; whilst another portion crosses to the *opposite* side, and forms part of *its* efferent trunks. Each spinal nerve, then, contains at least four sets of fibres—

I. A *sensory* bundle, passing upwards to the brain.
II. A *motor* set, conveying the influence of volition and emotion downwards *from* the brain.
III. A set of *excitor*, or centripetal fibres, terminating in the true spinal cord, or ganglion, and conveying impressions *to* it.
IV. A *motor*, or centrifugal set, arising from the same ganglionic centre (or true spinal marrow), and conveying the motor influence reflected *from* it to the muscles.

Of these, the *first* and *third* are united in the *posterior* or *afferent root;* the *second* and *fourth* in the *anterior* or *efferent root.*

The functions of the I. and II. bundles have been treated of when speaking of the spinal cord, as a conveyer of nervous influence to and *from* the brain. The III. and IV. are now to be considered in connexion with the cord as an *originator* of nervous influence. These latter, with the gray matter in the centre of the cord, constitute the *reflex system.*

The spinal cord has, in virtue of the gray matter in its composition, or the ganglionic cells collected in its interior, certain properties which characterize it as a central organ. It has a proper inherent motory power, which it communicates to its nerves independently of the brain, a fact which is proclaimed by the state of permanent contraction of those muscles, the sphincter, for example, which depend most immediately on the spinal cord. If an animal be stunned by a blow upon the head, or even decapitated, in some instances, it will still retain for some hours the power of moving the extremities when the integument is pinched, but without the least consciousness, or anything like volition; the motions are automatic, and proceed directly from the spinal cord, in consequence of an excitement or stimulation of its substance effected through the fibres of the spinal nerves that terminate in its gray substance; the motions are purely *reflex;* — in other words, motions which arise from stimuli conveyed to the spinal cord by centripetal or *afferent* nerves, which stimuli are reflected from the cord by centrifugal or *efferent* nerves.

These movements will also continue if the spinal cord be cut across, so as to make two segments, one for the upper and one for the lower extremity; each pair of members may be excited to movement by stimuli applied directly to themselves. The same phenomena are witnessed in the human subject when the spinal cord has suffered injury, or disease, in the middle of the back, provided the lower segment remain sound, and its nervous connexions with the limbs are uninjured. These facts prove that sensation is *not* a necessary link in the chain of reflex actions, all that is required being an *afferent* fibre, capable of receiving the impression and conveying it to the centre; a *ganglionic centre,* composed of vesicular nervous substance into which the afferent fibre passes; and an *efferent* fibre, capable of transmitting the motor impulse from the ganglionic centre to the muscle which is to be thrown into contraction (Fig. 199.)

There is scarcely any evidence of a disposition to reflex movements of the limbs of the human body during health, or in the waking condition, these movements being restrained by the controlling influence of the brain. But when the spinal cord is in a state of unnatural excitability, as in tetanus and in hydrophobia, or during the presence of strychnine in the system, or when the communication of cerebral influence to the limbs is cut off by disease of the spinal cord or brain itself, spasms may be excited in the extremities often by the slightest

Fig. 199.

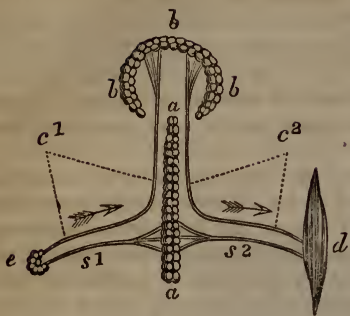


Diagram of the origins and terminations of the different groups of nervous fibres; *a a.* Vesicular substance of spinal cord. *b b.* Vesicular substance of brain. *e.* Vesicular substance at commencement of afferent nerve, which consists of c^1, the sensory nerve passing to the brain, and s^1, the spinal division, or excitor nerve, which terminates in the vesicular substance of the spinal cord. On the other side is the efferent or motor nerve, consisting of two divisions,—c^2 the cerebral portion conveying voluntary motion, and s^2, the spinal division, conveying the reflex power.

touch. It is to be understood in this explanation of the reflex system, that the spinal cord has the power of reflecting the action of sensitive nerves upon the motor nerves, without itself perceiving the impression, in other words, without possessing sensation, that being a function exclusively of the brain.

It is probable that all convulsive movements are produced through the agency of the spinal cord and medulla oblongata, either by irritation seated in the cord itself (*centric irritation*); or by causes seated at a distance, the irritation of which is transmitted to the spinal cord (*eccentric irritation*).

The *ganglionic system* of the lower orders of animals does not correspond with the *great sympathetic* or *ganglionic* of the higher (the latter system existing only in those of most perfect development), but with the *reflex* or *true spinal.* In the lower orders, the ganglia are scattered over various parts of the body, in the leech around the mouth; in the higher, they are collected into one common centre, the *spinal cord.*

In regard to the *functions of the columns of the cord*, nothing definite is settled. In the opinion of some physiologists (Bellinger and Valentin), besides being concerned in sensation and motion), when the *posterior column* is irritated, at the point where the nerves of either extremity are given off, that extremity is *extended;* and that when the *anterior* is irritated, the extremity is *flexed.* According to others (Todd and Bowman), if it could be proved that the anterior roots were exclusively connected with the antero-lateral columns, and the posterior roots with the posterior columns, then there would be ground for the belief that the functions of the columns correspond with those of the roots; but nothing is more certain than that both roots are connected with the antero-lateral columns; and there is a doubt as to whether the posterior roots have any connexion at all with the posterior column. Hence they are disposed to believe that the antero-lateral columns are both *motor* and *sensitive.* They are also disposed to believe that the posterior columns have a function different from that usually assigned to them. They may be in part commissural between the various segments of the cord, and in part subser-

vient to the function of the cerebellum in co-ordinating and regulating the movement necessary for perfect locomotion.

FUNCTIONS OF THE MEDULLA OBLONGATA.

The brain and spinal cord act on each other through the medium of the Medulla Oblongata; hence the importance of a knowledge of the course of the different columns or bundles of fibres of these parts. It consists of *four* principal parts. 1st. The *Anterior Pyramids*, or *Corpora Pyramidalia;* 2d. The *Olivary Bodies*, or *Corpora Olivaria;* 3d. *Restiform Bodies*, or *Corpora Restiformia;* sometimes called *Processus a Cerebello ad Medullam Oblongatum;* 4th. The *Posterior Pyramids*, or *Corpora Pyramidalia Posteriora.* (Figs. 200 and 201.)

Fig. 200.

Fig. 201.

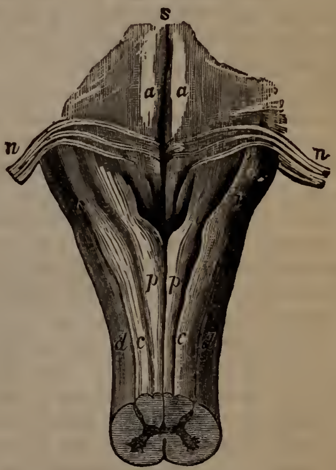


FIG. 200. — Front view of medulla oblongata. *p p.* Pyramidal bodies, decussating at *d.* *o o.* Olivary bodies. *r r.* Restiform bodies. *a a.* Arciform fibres.

FIG. 201. — Posterior view of medulla oblongata. *p p.* Posterior pyramids. *r r.* Restiform bodies, composed of *c c*, posterior columns, and *d d*, lateral part of antero-lateral columns. *a a.* Olivary columns, as seen on the floor of the fourth ventricle. *n n.* Fibres of seventh pair of nerves.

The *gray*, or *vesicular matter*, in this portion of the nervous centres is principally aggregated in three pairs of ganglionic centres, of which the *anterior* forms the nucleus of the olivary body, the *lateral* of the restiform, and the *posterior* of the posterior pyramidal.

In considering the functions of these parts it is impossible to separate them completely, they are so closely connected with each other, and the functions of one part are so readily affected by any change in

those of the others. In tracing the four divisions of the *medulla oblongata*, the following are found to be their connexions with the brain.

The *anterior pyramids*, which consist entirely of fibrous structure, may be said to connect the *motor* fibres of the cerebral hemispheres, with the antero-lateral columns of the spinal cord. They have also a connexion with the cerebellum. Part of their fibres decussate, a large portion of those that proceed from the right hemisphere passing over into the *left* side of the cord; and those from the left hemisphere into the right side of the cord,—an arrangement which fully explains the frequent occurrence of paralytic affections on the opposite side from that affected in the brain.

The *olivary bodies* probably constitute the essential portion or *nucleus* of the medulla oblongata, that on which its power as an independent centre depends. This opinion seems supported by the fact, that these bodies and the central portion of the medulla oblongata contain that intermixture of *vesicular* and *fibrous* matter which constitutes the main character of a nervous centre. It is probably the centre of the *respiratory nerves.* The olivary bodies are connected above with the cerebral hemispheres and corpora quadrigemina, and below with the antero-lateral columns of the spinal cord.

The *restiform* bodies are believed to be associated in function with the hemispheres of the cerebellum, and the *posterior columns* of the spinal cord; a band of arciform fibres, however, passing over to the antero-lateral column on each side.

The *posterior pyramids* are supposed by some to have the function of connecting the different segments of the cord with each other. By Mr. Solly, the gray nuclei, situated immediately beneath the fourth ventricle, are regarded as the ganglia of the sense of hearing.

The medulla oblongata, has the general properties of the spinal cord. It has the same property of *reflection*, indeed, in a higher degree than any other part of the nervous system; and the nerves which arise from it are more prone than any others to reflex action. It belongs also to the motor apparatus, and no other part has so great an influence on the production of motion, irritation of it exciting convulsions in the whole trunk. The most important motory influences of the medulla oblongata, however, are those that subserve *respiration* and *deglutition*, both of which, respiration more especially, depend upon it. All the rhythmical motions of respiration, such as laughing, yawning, sighing, &c., depend upon it. In considering these lines of communication, as establishing connexions with the encephalon above and the spinal cord below, it will be seen that there are two sets; one forming the restiform bodies, which connect the cerebellum with the posterior columns of the spinal cord; whilst there is another division, which comes into connexion through the olivary and pyramidal bodies, with the anterior and antero-lateral columns. The latter fibres may be considered as forming two principal tracts, the *sensory* and the

motor; these being so named from the character of the nerves which arise in their course. The *sensory* tract passes upwards from the posterior columns of the spinal cord, and the posterior part of the lateral to the thalami optici; in the upward course it receives the sensory root of the fifth pair, and while passing through the pons varolii undergoes partial decussation; it is obviously continuous below with the tract from the posterior roots of spinal nerves. The *motor* tract may be regarded as descending from the corpora striata and tubercula quadrigemina into the *anterior* and *antero-lateral* columns of the spinal cord; in its course it gives off the roots of all the motor nerves usually considered as cranial, and the greater part of its fibres undergo decussation below the pons varolii. The *medulla oblongata*, therefore, is to be regarded in a twofold light: *first*, as a medium of communication between the higher parts of the *encephalon* and the *spinal cord;* second, as an independent nervous centre for the reflex movements that issue from it, more especially those of *deglutition* and *respiration*.[1] The different tracts described above are seen in Fig. 202. It is doubtful how far the medulla oblongata participates in sensation (as alleged by Desmoulins, Magendie, Flourens). Any conclusion in

Fig. 202.

Dissection of the Medulla Oblongata, to show the connexions of its several strands:—A, corpus striatum; B, thalamus opticus; C, D, corpora quadrigemina; E, commissure connecting them with the cerebellum; F, corpora restiformia; P, P, pons varolii; *st*, *st*, sensory tract; *mt*, *mt*, motor tract; *g*, olivary tract; *p*, pyramidal tract; *og*, olivary ganglion; *op*, optic nerve; 3*m*, root of the third pair (motor); 5*s*, sensory root of the fifth pair.

this direction from experiments must be unsatisfactory, inasmuch as all the phenomena that have been noted are readily referred to reflex actions.

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[1] Carpenter's Elements, 2d American edition, p. 506.

All the psychological excitements or faculties,—affections, passions, &c., are realized, or made manifest by means of the medulla oblongata; and in those diseases which mental emotion is apt to give rise to, many of the symptoms are referable to affections of the medulla oblongata.

The chief *excitor* nerve of the respiratory movements, is the *afferent* portion of the par vagum; the *afferent* portion of the fifth is also a powerful excitor. The chief *motor* nerves are the *phrenic* and *intercostals*, which probably *originate* in the medulla oblongata, though they issue from the cord at a point lower down. Several other spinal nerves are concerned in the motor portion of the respiratory process, as are also the facial nerve, the motor portion of the par vagum, and the spinal accessory.

In the movements of *deglutition*, which are purely *reflex*, the chief *excitor* is the afferent portion of the *glosso-pharyngeal*, assisted by the branches of the *fifth*, distributed upon the fauces. The *motor* nerves are the pharyngeal branches of the par vagum, assisted by the facial, hypoglossal, *motor* portion of the fifth, and, perhaps, also, the motor portions of some of the cervical nerves. The medulla oblongata is also concerned, in its reflex action, in governing the aperture of the glottis, which it does through the agency of the *superior laryngeal branch* of the par vagum, the *afferent nerve*, and the *inferior* or *recurrent laryngeal*, the *efferent* or *motor nerve*.

ENCEPHALIC GANGLIA.

The medulla oblongata is connected superiorly, as was before stated, with certain gangliform bodies, which have also their proper functions. These are the *Corpora Striata*, the *Optic Thalami*, and the *Tubercula Quadrigemina*. The *corpora striata* and the *optic thalami*, whilst both connected with the cerebral hemispheres by commissural fibres, are, in the most marked way, connected inferiorly with separate and distinct portions of the *medulla oblongata*; the *corpora striata*, with the anterior pyramids, and the *optic thalami* with the olivary columns, the central and probably fundamental portions of the medulla oblongata. Thus along the tract that passes from the *anterior pyramids* to the corpora striata, we have none but *motor* nerves: whilst along the tract that connects the olivary columns with the thalami, there are none but *sensory* nerves. The thalami then may be regarded as the ganglionic centres of *common sensation*, standing in the same relation to the sensory nerves, converging from the various parts of the body to the encephalon, as do the optic and other ganglia to their nerves of *special* sensation. On the other hand, the corpora striata are implanted on the *motor* tracts which descend into the anterior pyramidal column; and their connexion with the *motor* function is very generally admitted, from the constancy with which paralysis is observed to accompany lesions of these bodies. From the fact that

sensory impressions can be felt, and automatic movements of a higher grade than the simply reflex, can be called into play after removal of the peripheral portion of the cerebrum, provided these ganglia be left untouched, and from the fact of their constituting the mass of the encephalon in the lower animals who manifest consciousness, and execute movements directed by sensation, there can be scarcely a doubt that these ganglia preside over consciousness even in man, the mere superaddition of the peripheral ganglia by no means altering their endowments as present in the lower animals. The movements that result from these centres differ from the ordinary reflex movements in requiring that the impressions which originate them shall be *felt;* hence they are designated as *consensual.*

According to the views above expressed, the corpora striata and optic thalami bear to each other a relation analogous to that of the anterior to the posterior horn of the spinal gray matter. The corpora striata and anterior horns are centres of motion; the optic thalami and posterior horns, centres of sensation.

The *tubercula quadrigemina* are the true optic ganglia, the encephalic recipients of the impressions necessary to vision, which, according to Bowman, are doubtless simultaneously felt by means of the optic thalami; they are also the centres of those movements of the iris which contribute largely not only to protect the retina, but likewise to increase the perfection of vision. Irritation of an optic tubercle on one side causes contraction of both irides.

This is quite in accordance with the fact, that if light be admitted to one eye so as to cause contraction of its pupil, the other pupil will contract at the same time. Whatever other functions the tubercula quadrigemina may perform, they have a sufficiently obvious relation to the optic nerves, the eye, and the sense of vision. They may therefore be justly reckoned as special ganglia of vision.

At the base of the brain are found other ganglionic masses, which are in direct connexion with the nerves of sensation, and appear to have functions quite independent of those of the other components of the encephalon. Anteriorly are found the *olfactive ganglia*, in what are commonly termed the *bulbous expansions* of the olfactory nerve. That these are *real* ganglia is proved by their structure (containing gray or vesicular matter), their relation to the olfactory nerves, their direct proportion of bulk to that of these nerves, and to the development of the olfactory apparatus. The *auditory ganglia* are not so clearly made out. In higher animals, and man, the auditory nerve can be traced into a small mass of vesicular matter which lies on each side of the fourth ventricle, which may be considered as having a character of its own, and that it is really the ganglionic centre of the auditory nerve. The ganglia of the *sense of touch* may be considered as existing in the ganglia on the posterior roots of the spinal nerves, and of the fifth pair. As this sense is diffused over the whole body, it would seem to need ganglia in connexion with those nerves which receive the tactile

impressions. The *gustatory ganglion* is a collection of gray or vesicular matter, imbedded in the medulla oblongata, which is considered by Stilling to be the nucleus of the glosso-pharyngeal nerve, and to which a portion of the sensory root of the fifth pair may be traced.

FUNCTIONS OF THE CEREBELLUM.

On this point there has been, and is still, much discussion. Some regarding it as the organs of the sexual impulse; others, as being connected with the function of motion.

The development of the cerebellum in the scale of animals bears no relation to the energy of the sexual impulse. In the amphibia (as frogs and toads) this organ is extremely small, constituting a mere band lying over the fourth ventricle, and nevertheless the sexual instinct of these animals is proverbial, although they have no erectile organ. The same thing is true of the monkey and the kangaroo, both remarkably salacious, and yet with an inconsiderable development of the cerebellum. Pathological evidence is also against the phrenological doctrine; instances are on record of partial, and even total absence of the organ, without the destruction of the sexual passion. In the first case the individual was married, and the father of several children. In the other there was a tendency to masturbation.

The experiments of Flourens, Hertwig, Rolando, and others, show that after the removal of the cerebellum the animals lost the power of executing the movements necessary for locomotion; stupor in these instances was never produced, nor the sensibility of any part of the body destroyed; the power of muscular movements *only* was lost; neither were convulsions ever produced. By the time the last portions of the organs were removed the animals had lost entirely the power of springing, flying, walking, standing, and preserving their equilibrium. All these mutilations were performed without the animal's evincing any sensibility in the cerebellum while it was being removed. There was no loss of volition or sensation, but merely of the faculty of combining the action of the muscles in groups. These facts have led most physiologists to adopt the opinion that the cerebellum has for its function, the *regulation* and *harmonization*, or *coordination* of *muscular* movements, especially those of a voluntary character.

This opinion is further substantiated by the observations of Leuret and Lassaigne, which show conclusively that the cerebellum is *larger* in geldings, which are commonly used for draught purposes, and in whom the number of muscles employed is consequently great, than it is either in the mare or stallion, the latter of which is kept especially for the purpose of propagation, and is much less applied to occupations which call forth their motor faculties. The cerebellum is connected with the medulla oblongata and spinal cord by the restiform bodies, and the posterior columns of the cord, and with the mesoce-

phale by the fibres of the pons. Thus this organ is brought into union with each segment of the great nervous centre, upon which all the movements and sensation of the body depend.

FUNCTIONS OF THE CEREBRAL HEMISPHERES.

The fact of the cerebral hemispheres having a more perfect development in proportion as the animals in which we examine them are higher in the scale of vertebrata, from fishes up to man, and the coincidence of atrophy and the absence of the convolutions on their surface with idiotcy, are alone sufficient to indicate that the seat of the higher intellectual faculties must be sought for in this part of the encephalon. The primitive fibres which go to the constitution of the cerebral hemispheres have least of all to do with the simple motory and sensitive operations of the nervous substance. All inquirers agree in representing the hemispheres as altogether insensible; they may be cut, pricked, and either partially or entirely removed without any feeling of pain being excited. Wounds of this part of the encephalon, moreover, give rise to no convulsions; the only constant effect of a deep incision is blindness of the eye of the opposite side, and a state of stupidity. These investigations, while they render more precise the functions of the cerebrum, have also tended to *limit* them.

It has also been shown that this organ is *not essential to life*, that it must be considered as an organ *superadded* for particular purposes; that it has no representative in the lowest classes of animals, and that when it first makes its appearance in fishes, it evidently performs a subordinate part in the general actions of the nervous system. Hence, whatever be its function, it should be remembered that it does not deprive other parts of their independent powers, although it may keep them in check, and considerably modify their manifestation.

The experiments instituted by the same physiologists above mentioned, go to prove that the cerebrum is the organ of *intelligence.* Animals from whom the hemispheres were removed, had constantly the appearance of deep sleep, and when irritated resembled in their motions an animal just awaking. M. Flourens likens them to an animal condemned to perpetual sleep, but deprived even of the faculty of dreaming. A hen, in which Hertwig had cut away the hemispheres nearly to the base of the brain, was found to be deprived of sight, hearing, taste, and smell; it sat constantly in one spot, and was as if dead, until strongly roused, when it moved a few steps; it neither fed itself, nor drank, nor attempted to avoid danger. It is evident from these experiments, and from the effects of pressure on the cerebral hemispheres in man, *that they are the seat of the mental functions;* that in them resides the power of directing the mind to particular sensorial impressions,—the faculty of attention.

The portions of the cerebral hemispheres that possess these elevated

functions are the *convolutions.* The complexity of the convolutions in the animal scale is in the direct ratio of the advance of intelligence. In infancy they are imperfectly developed, and their increase in size goes on simultaneously with the advance of mental power. If their growth be arrested, the mental powers are of the feeblest kind. In idiots the brain is not only small, but the convolutions are exceedingly limited. The *object* of these convolutions is to afford as extensive a surface of the gray or vesicular matter in as small a space as possible. By this arrangement, also, a more ready access is permitted to the blood-vessels on the one side, and a more free communication on the other with the vast number of fibres by which its influence is to be propagated.

It is evident, that if the surface of the gray did not exceed that of the white matter, folds or convolutions would not be necessary, but a simple expanse of the former would suffice to cover the surface of the latter. The existence of convolutions on the surface of the hemispheres affords evidence of a large relative amount of the dynamic or vesicular nervous matter, and their number or complexity is a measure of the extent to which the vesicular surface is increased. Of two brains, equal in bulk, the one that has most convolutions has most vesicular matter, and is, physiologically, the more potential. It has been calculated that the entire surface of the human cerebrum, when the convolutions are unfolded, is equal to about 670 square inches.

The *weight* of the *entire* encephalon in the adult male usually ranges between 46 and 53 ounces; in the female, from 41 to 47 ounces. The maximum is about 64 ounces or *four pounds;* the minimum about 31 ounces, or rather less than *two pounds.* In the idiot it is often much below this, as, for instance, 20 ounces. The cerebral hemispheres alone weigh about *four times* as much as the rest of the cerebro-spinal mass.

The brain is abundantly supplied with blood by the vertebrals and carotids, which anastomose very freely with each other, to obviate the effects of pressure upon either of them. Their course is also a tortuous one, that the impulse of the blood upon so delicate an organ may be avoided.

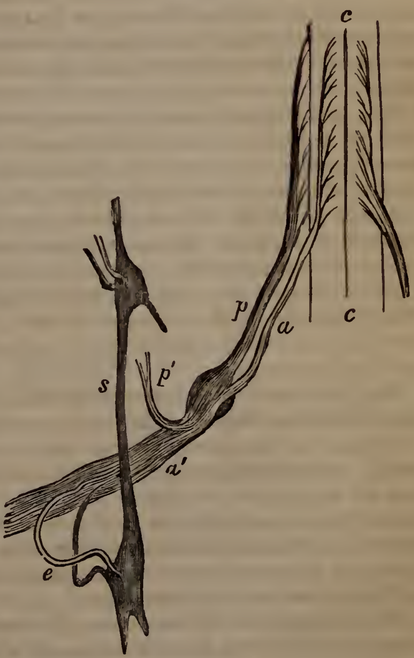
A certain amount of regulated pressure upon the walls of the vessels of the brain is essential to the proper exercise of its functions. It is known that the amount of blood circulating through the brain varies at different times in accordance with its increased or diminished functional activity, and that the cranial case is not an unyielding one, as its contents would then be invariable. A special provision is made to meet this varying amount of fluid, and to keep up the same degree of pressure upon the organ, in the existence of a fluid beneath the arachnoid wherever the pia mater exists. The amount of this fluid averages about 2 ounces, but in cases of atrophy of the brain, as much as 12 ounces may be obtained from the cranio-spinal cavity; whilst in all instances in which the bulk of the brain has undergone an increase

either from the production of additional nervous tissue, or from undue turgescence of the vessels, there is either a diminution, or a total absence of this fluid. It has been shown by Magendie that the withdrawal of this fluid in living animals always causes great disturbance of the cerebral functions, probably by allowing undue distension of the blood-vessels. It is, however, speedily renewed, and its reproduction restores the nervous centres to their normal condition.

FUNCTIONS OF THE SYMPATHETIC.

This nerve has been variously called the *splanchnic*, *ganglionic*, *vegetative* and *organic*. It consist of an uninterrupted chain of ganglia, extending on each side of the vertebral column, from the first cervical vertebra down to the coccyx, and moreover extending upwards beside the cranial vertebræ, and occupying spaces between the bones of the cranium and those of the face. The chains of the opposite sides communicate with each other at various points in the plexuses of nerves that originate from them, and through the *ganglion impar*, a single ganglion in front of the coccyx. A *cephalic* communication is described by Ribes in a *ganglion impar* situated upon the *anterior communicating artery* of the circle of Willis, and other anatomists regard the pituitary body in the sella turcica as a ganglion of like description,—a common point of union for the right and left chains at their cranial extremities.

Fig. 203.



Roots of a dorsal spinal nerve, and its union with the sympathetic. *c. c.* Anterior fissure of the spinal cord. *a. p.* Anterior and posterior roots. *s.* Sympathetic. *e.* Its double junction with the anterior branch of the spinal nerve, by a white and a gray filament.

The peculiarities of the sympathetic fibres were spoken of when describing the development of the nervous system (page 241).

The sympathetic system contains two sets of nervous fibres,—the ordinary white tubular fibres, which it derives from

the cerebro-spinal system; and the *gray* or *gelatinous* fibres, which belong exclusively to itself.

Each of these systems thus mingles with the other, the cerebro-spinal transmitting both motor and sensitive fibres into the sympathetic; whilst the sympathetic is represented in the cerebro-spinal system by certain fibres and collections of vesicular matter of its own (Fig. 203.)

Adopting this view of the compound nature of the sympathetic, it seems to be impossible to regard it either as independent of the cerebro-spinal centres, or wholly depending upon them. It is probably independent of them as regards its gelatinous fibres, but dependent upon them as regards its tubular fibres. It is to be looked upon as a portion of the nervous system, peculiar in its composition, having, as regards some of its constituent fibres, a special relation to the blood-vessels, especially the arteries, but being by its other fibres connected with the cerebro-spinal centres. It is also distributed both to sentient surfaces and to muscles, as to the heart and intestinal canal, movements in which can be excited by stimulation of the ganglia connected with them. The well-known occurrence of pain in parts supplied by it, proves the existence of sensitive fibres.

The sympathetic thus appears to exercise a threefold office: first, that of a sensitive nerve to the parts to which it is distributed; secondly, that of a motor nerve for certain muscular parts; and thirdly, that of a nerve to the blood-vessels. By the last arrangement it may influence nutrition and secretion by its effect upon the chemical constitution of their contents, as light does upon the contents of vegetable cells. The effect of the emotions operating through this channel upon the blood-vessels is seen in the act of blushing, and also in the pallor that often accompanies them.

SENSATION.

By this term is meant *the perception of an impression.* It is with the brain alone that the mind possesses the relation necessary for the production of sensation. Hence the brain is often called the *sensorium.* Sensations are of two kinds, *external* and *internal.* By the first are meant those that arise from impressions made upon the external surface of the body, as in the senses of sight, teuch, or hearing. The *internal* are such as occur within the body, and arise from some alteration in the function of the part, for the time being. Hunger and thirst are internal sensations.

With regard to all sensations, it must be remembered that the change of which the mind is informed, is *not* that which occurs at the peripheral extremity of the nerves, but the change communicated to the sensorium; in other words, sensation does not occur at the point impressed, but in the brain. Hence it happens that sensations often occur from impressions upon a nerve somewhere in its course. This is of frequent occurrence in the senses of sight and hearing, flashes of light being seen, and ringing sounds being heard, when no exter-

nal stimuli could have produced such impressions. In such cases they not unfrequently arise from impressions made on these nerves in their course from special ganglia to their peripheral termination. This variety of sensations is termed *subjective*, to distinguish them from *objective*, in which the stimuli are derived from without. The most common cause of these subjective sensations is congestion or inflammation in the course of the nerve.

Whenever an impression is made upon a nerve in its course, the mind instinctively refers it, not to the point impressed, but to the ordinary termination of the nerve upon the periphery of the body, even although these terminations should not exist, or should be incapable of receiving impressions. Thus, after amputations, the patients are often troubled with sensations which they refer to the removed extremities; and in like manner, after the Taliacotian operation, all sensations produced by touching the nose are referred to the forehead, from whence the flap was taken, until the new vascular and nervous communications are established.

An active capillary circulation in a part is essential to its sensibility; any cause which retards this deadens the sensibility of the part, as is well seen in the benumbing influence of cold. Increased vascular action, again, produces a corresponding increase in sensibility; this is seen in the active congestion preceding inflammation.

Sensations are divided into *general* and *special. General sensation* is distributed over all the body; by it we feel those impressions made upon our bodies by surrounding objects, which produce the various modifications of *pain* and *pleasure*, the sense of contact and resistance, and variations of temperature. *Special sensation* is that which arises from impressions of a peculiar character, upon nerves which are adapted to receive them alone.

The intensity of all sensations is very much blunted by frequent repetition, excepting in the case of those to which the attention is particularly directed; these, so far from losing their acuteness, become much more cognizable by the mind. Hence arises the educability of the special senses.

Although there are some stimuli which can produce sensory impressions on *all* the nerves of sensation, it will be found that those, to which any one organ is peculiarly fitted to respond, produce little or no effect upon the rest. Thus the ear cannot distinguish luminous rays, nor the eye the undulations of sound; and the same is true of the other senses. Hence it may be inferred, *that no nerve of special sensation can, by any possibility, take on the function of another. But that each requires its own peculiar stimulus to call it into action, light for the eye, and sound for the ear, &c.*

The nerves of *special* sensation have in themselves no *general* sensibility; they may be pricked or torn without the individual suffering any pain; they only experience or give rise to their own peculiar sensations. All the general sensibility that the organs of the senses

possess is derived from nerves of general sensibility distributed to them. The *special senses* are five in number, viz.: *Touch*, *Taste*, *Smell*, *Hearing*, *Seeing*. To these some add a *sixth*, the *muscular sense*, or that by which the will can produce, check or regulate the amount of contraction in the voluntary muscles; and also appreciate, by certain sensations originating in the muscles, the precise degree of contraction in each.

The *organs* of the special senses consist of two parts, a *physical* and a *vital* part. The physical part receives and modifies the impression; the vital transmits the impression to the brain. The different transparent media of the eye contribute its physical portion; the *nerve* is the vital portion.

SENSE OF TOUCH.

Of all the senses, Touch is the most extensively diffused throughout the animal kingdom; it is the simplest and most rudimentary of all the special senses, and may be considered as an exalted form of *common sensation*, from which it arises by imperceptible gradations till it reaches its highest development in some particular parts. It is also the earliest called into operation, and the least complicated in its impressions and mechanism.

The sense of touch is most highly developed in those parts that are most abundantly supplied with sensory nerves. In the lips, the tip of the tongue, and the palmar aspect of the last joints of the fingers, the nerves are both very numerous and superficially distributed, and whilst the epidermic layer is thinner, there is at the same time a greater degree of isolation of the papillæ of the skin between lines and furrows of the epidermis. The number of these lines or furrows is commensurate with the development of the sense. Even in man the acuteness of the sense of touch varies much in different regions of the body, as can be proved by observing the varying distances at which the two points of a pair of compasses can be separately recognised on different parts of the surface; on the points of the fingers they can both be recognised at a distance of one-third of a line, while they require to be separated thirty lines in order that the two points may be recognised over the spine.

The nerves of touch are the same as those of general sensation, viz.: the posterior roots of the spinal nerves, and some fibres of the fifth and eighth cerebral nerves. They are distributed to the tactile papillæ of the skin, small elevations enclosing loops of blood-vessels and branches of the sensory nerves, (Fig. 204), situated on the exterior surface of the cutis vera. The papillæ are covered by the epidermis, which protects them from too violent impressions of external bodies upon them.

In the sense of touch the body to be examined must be brought into contact with the sensory surface. The only exception to this is

in regard to the sense of temperature, for which there would seem to be a distinct set of nerves.

Fig. 204.

Papillæ of the palm, the cuticle being detached.

The only idea communicated to our minds by the sense of touch, is that of *resistance*. By the various degrees of resistance which the sensory surface encounters, we obtain a knowledge of the hardness or softness of a body. When the sensory surface and the substance touched are moved upon each other, we obtain a notion of extension or space. At the same time, by the impressions made upon the tactile surface, we discover the roughness or smoothness of the substance. The knowledge of *form* and *weight* is derived by the additional assistance of the *muscular sense*.

Fig. 205.

Upper surface of tongue. *a*. One of the circumvallate papillæ; *b*, one of the fungiform; *d*, conical papillæ.

The sense of touch is exceedingly educable, as is seen in the case of the blind, who can be taught to read, and even distinguish colours, by its agency.

Impressions made upon the organ of touch continue perceptible for some time after the stimulus has been removed; for instance, the stinging of a smart blow does not soon subside, and the simple contact of an article of clothing often leaves the impression of its presence after it has been removed. The *subjective sensation* pertaining to the nerves of this sense are among the best known. The tingling of a limb that is "asleep," which commonly depends on pressure on its trunk, may also result from changes in the centre; the same is true of formication, heat, chilliness, itching, and also of pain.

SENSE OF TASTE.

In the sense of taste, as well as in touch, the substance to be examined must be brought into contact with the organ of the sense,

which organ is the mucous membrane of the tongue and fauces. The mucous membrane of the tongue is largely supplied with papillæ of various forms, which are abundantly supplied with nerves and blood-vessels. The papillæ are of three varieties: 1st. The *calyciform* or *circumvallate*, situated at the base of the tongue in a V-shaped line, *a* (Fig. 205), the *fungiform*, on the sides and apex *b;* and the *conical*, or filiform, the most numerous, and most abundant, in the central part, *d*. The latter are supposed to be concerned rather in the sense of touch than of taste. When these papillæ are called into action by the contact of substances having a strong savour, they become turgid and erect, so as to produce a decided roughness on the surface of the organ.

There is no special nerve of taste; the sense seems to be divided between the glosso-pharyngeal and the fifth. The impressions made upon the front of the tongue are conveyed by the fifth; those upon the back of the organ by the glosso-pharyngeal. The first ministers also in general sensibility; the latter conveys the impressions that produce nausea. It is also the afferent nerve in the reflex act of swallowing. The ninth pair is also distributed to the tongue, but it is a *motor* nerve, and not at all concerned in the special sense.

A necessary condition for the exercise of this sense, is solubility of the substance to be tasted; if it be insoluble it merely excites the feeling of contact. The sapid substance should also be moved over the surface of the tongue; by this means the taste is very much heightened. In this respect there is a strong analogy between touch and taste. Taste may also be produced by mechanical irritation or chemical excitation of its nerves. A smart blow of the finger, or galvanism, will often excite a taste, sometimes acid, at others alkaline. A large part of the impression made by sapid substances is received through the sense of smell, as may easily be proved by attempting to taste any substance while holding the nose. In inflammation of the Schneiderian membrane too, we lose the power of appreciating the flavour of bodies through the impairment of the sense of smell.

Taste is an educable sense, as is seen in the case of spirit-tasters, but it is not considered an intellectual one. Its *subjective* phenomena are not so strongly marked as in some of the other senses, and yet we are constantly experiencing pleasant or unpleasant tastes without any apparent cause. Magendie states that dogs, into whose veins he had injected milk, licked their lips as though they tasted it.

The sense of taste is designed to guide us in our search for food; it is therefore placed at the entrance of the digestive apparatus. Impressions of taste remain longer than those of other senses; but the after-taste itself is not always the same as the original.

Cold air deadens the sense of taste, precisely as it is known to do in the sense of touch.

SENSE OF SMELL, OR OLFACTION.

This sense is designed to acquaint us with the odorous qualities of particles suspended or dissolved in the atmosphere. It is seated in the mucous membrane of the nose, and at the commencement of the respiratory passages, that it may protect them against the entrance of deleterious matters. Its principal use, however, is to second the impressions of taste in conveying intelligence of the properties of food.

The organ of the sense of smell has no capacity of movement in relation to its ordinary stimuli; the odorous particles are brought into contact with it in the act of inspiration. These particles are so small as to elude detection by the most delicate experiments. The whole mucous membrane of the nose is not endowed with the sense of smell; it seems to be limited to that portion expanded over the *superior* and *part of the middle spongy bones.* This region is therefore called the *olfactory region.* It is *to this portion only* that the *olfactory nerve* is distributed. The other portions of the mucous membrane are supplied with branches of the *fifth pair,* from which they obtain their general sensibility. These branches are derived from the ophthalmic and superior maxillary divisions. When the fifth nerve is diseased, irritating substances may be introduced into the nose without discomfort to the patient. Section of the fifth pair also arrests the secretion from the mucous membrane, and in that way diminishes the acuteness of smell. This nerve is the *afferent* or *excitor* nerve in the reflex act of sneezing.

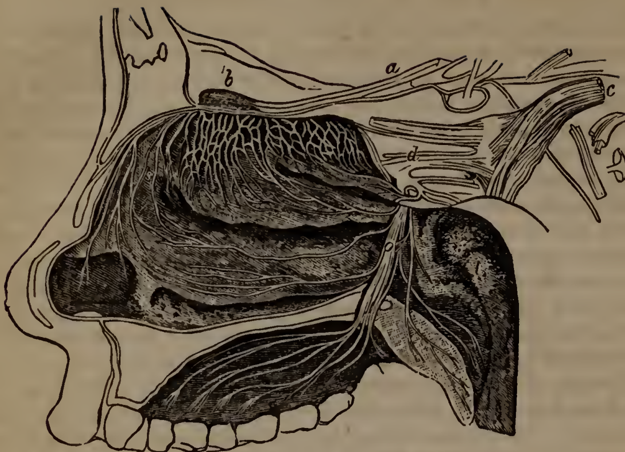
The organ of smell is seated high up in the nose, not only to protect it from mechanical injury, but that it may be screened from the contact of air either *too cold* or *too dry.* The convoluted arrangement of the turbinated bones, with their expansion of mucous membrane, effects this. These parts break the force of the current of air, warm it, and impart that degree of moisture which is best calculated to aid the solution of the odorous particles on the sentient surface to which they are to be applied.

The olfactory nerve passes down from the olfactory bulb or ganglion through the cribriform plate of the ethmoid bone, and is distributed in minute threads having a plexiform arrangement (Fig. 206). Their ultimate distribution is probably in *loops.*

The *conditions* requisite for the exercise of the sense of smell are, in addition to the integrity of the nervous apparatus, a healthy condition of the mucous membrane. If it be dry, or in a raw, irritable state, with a watery discharge, the sense is lost or impaired. This is familiarly seen in a *cold in the head.* The substance to be smelt must also be *soluble;* insoluble substances cannot be perceived by this sense. When we wish to examine any substance closely, it is drawn up into the nose with some force, in order that the odorous particles may reach the olfactory region.

The sense of smell, although not an intellectual sense, is susceptible

Fig. 206.



a. Olfactory process. *b.* Olfactory bulb. *c.* Fifth nerve within the cranium. *d.* Its superior maxillary division, anastomosing with the olfactory filaments, and with *s*, branches of the nasal division of the ophthalmic nerve. *o.* Posterior palatine twigs from Meckel's ganglion, supplying the soft and hard palate.

The cut represents the outer wall of the nasal fossa, with the three spongy bones and meatus.

of cultivation; by it individuals are often capable of recognising others, and even, as in one instance, to discover their own clothes among many others.

Subjective phenomena sometimes occur in this sense, arising, as in the others, from irritation by an internal cause. Disease of the olfactory bulb, or of the anterior lobe of the brain, has been known to produce them. Müller relates the case of a man, who ever after a fall from his horse, believed that he smelt a bad odour. Whether substances introduced into the circulation would excite the olfactory nerve to the perception of the odour, has not been ascertained experimentally.

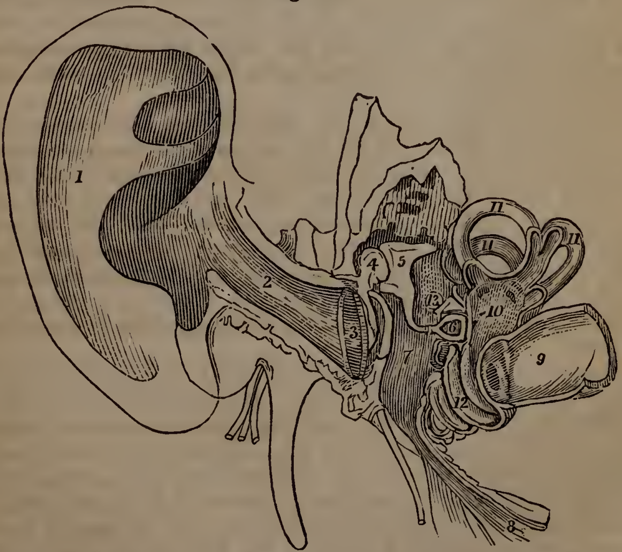
The cavities that communicate with the nasal passages have no connexion with the sense of smell.

HEARING, OR AUDITION.

By the sense of hearing the mind takes cognizance of the condition of the auditory nerve produced by those oscillations of elastic matter which give rise to the phenomena of sound. The communication of these oscillations to the ear may take place through the air, or through the intervention of some solid conductor, brought into immediate connexion with the organ of hearing. The following account of the organ is condensed from the eighteenth chapter of Todd and Bowman's Physiological Anatomy. The essential part of the organ of

hearing is a sac, containing fluid, upon which the nerve of hearing is freely distributed; this sac being in connexion with the cranial parietes. This is represented in the human subject by that small cavity excavated in the petrous portion of the temporal bone, called the *vestibule*. This, and *three semicircular canals*, with a spirally-disposed canal, divided by a partition, constituting the *cochlea*, form the *labyrinth*. External to this, and situate between the squamous and petrous portions of the temporal bone, is a cavity, the *tympanum*, which in front further communicates very freely with the cavity of the throat through an open canal, the *Eustachian tube*, whereby air has free access into the tympanum. This cavity is closed on the outside by the *membrana tympani*, which extends over its external orifice as a drum. A small chain of bones extends from this membrane to another in the inner wall of the tympanum (the membrane of the foramen ovale). These are the *ossicles* of the ear. These small bones are articulated by moveable joints, and are moved by small muscles, which are thus enabled to regulate the tension of the membrana tympani, as well as of the membrane of the vestibule. Externally is an apparatus for collecting sounds and conducting them to the tympanum, called the *external ear*, comprising the free expanded part, the *auricle*, and the *auditory canal*, or *meatus externus*. (Fig. 207.)

Fig. 207.



1. Pavilion. 2. Meatus externus. 3. Membrana tympani. 4, 5, 6. Chain of bones. 7. Cavity of tympanum. 8. Eustachian tube. 9. Meatus internus. 10. Vestibule. 11. Semicircular canals. 12. Cochlea. 13. Stapedius muscle.

The *auditory nerve* is the *portio mollis* of the seventh pair, which is distributed to the vestibule, cochlea, and semicircular canals. Its mode of termination is unsettled. It will be seen from this description of the auditory apparatus that it is divided into three parts. 1st. *External ear;* 2d. The *middle ear,* or *tympanum;* 3d. The *internal ear.*

Sounds may be propagated in three ways: by *reciprocation;* by *resonance;* and by *conduction.* Vibrations of *reciprocation* are excited in a sounding body when it is capable of yielding a musical tone of definite pitch, and another body *of the same pitch* is made to sound near it. Thus, if two strings of equal tension be placed side by side, and one be thrown into vibrations, the other, although untouched, will be thrown into corresponding vibrations. The same is true of membranes as of strings. If a membrane and a string both capable of yielding the same note, be placed side by side, and one be thrown into vibrations, the other will reciprocate. But no membrane or string will reciprocate any tone that is lower than its own *fundamental note,* by which is meant, the *lowest note* which it will yield when the whole of it is in vibration together.

Vibrations *of resonance* occur when a sounding body, as a tuning-fork, is placed in connexion with any other, of which one or more parts may be thrown into reciprocal vibrations, even although the tone of the whole be different, or it be not capable of producing a definite tone at all. If a tuning-fork, whilst vibrating, be placed in contact with a sounding-board, the board will divide itself into a number of parts, each of which will reciprocate the original sound so as greatly to increase its intensity.

Vibrations of conduction are the only ones by which sounds can be said to be propagated. If the ear be placed at one extremity of a long board, and the other be lightly struck, the sound will be *conducted* to the ear along the whole length of the board. All media are capable of conducting sound, a vacuum being the only space through which it will not pass. Solids are better conductors than fluids, and fluids than gases. The greatest diminution in the intensity of sound is usually perceived, when a change takes place in the medium from which it is propagated, especially from the aeriform to the liquid.

The *object* of the *external ear* is to receive sonorous vibrations, concentrate and conduct them inwards. The various elevations and depressions of the external ear adapt it peculiarly to catch the sonorous waves arising from opposite quarters. The *auditory canal* — *meatus externus* — receives the sonorous pulses immediately, and conducts them to the *membrana tympani.* The sound is at the same time strengthened by reflection from the walls of the meatus, and the resonance of the mass which it incloses; the walls of the passage, moreover, are solid conductors of sound.

The use of the membrana tympani is to receive the sonorous un-

dulations in such a manner as to be thrown into *reciprocal vibration*, which is to be communicated to the chain of bones. It cannot, however, reciprocate any sounds that are lower than its own fundamental note; hence, if it be unduly tense from any cause, the individual will be deaf to low sounds. In its natural condition it is rather *lax* than tense; by this means it can reciprocate a greater variety of sounds. The integrity of this membrane does not seem to be essential to hearing, since it may be perforated, or destroyed, without the loss of the sense.

The *chain of bones* is intended to *conduct* the sonorous undulations across the tympanum to the internal ear. The *tensor tympani muscle* which is inserted into the handle of the *malleus* has a protective agency over the organ of hearing, analogous to that of the *iris*. When this muscle contracts it draws in the handle of the malleus and renders the membrana tympani tense, and thus takes away from it the power of reciprocating low sounds. It is also capable of being excited to reflex action by *loud* sounds, and thus putting the membrane into such a state of tension as not to reciprocate them. It may, therefore, be fairly compared to the iris, which contracts ever the more powerfully the stronger the light that impinges upon it.

The *tympanum* isolates the chain of bones and allows free vibration to the membrane at either end of it. Moreover the air which it contains reverberates, and the walls and neighbouring spaces and cells reflect sonorous pulses, which thus fall strengthened upon the walls of the labyrinth, and particularly upon the membrane of the fenestra ovalis and fenestra rotunda. The principal use of the Eustachian tube seems to be, to maintain the equilibrium between the air of the tympanum and the external air, so as to prevent undue tension of the membrana tympani. It also serves to conduct away the secretions of the middle ear, which it discharges into the cavity of the throat by means of ciliæ vibrating upon its surface.

In regard to the uses of the different parts of the labyrinth nothing certain is known. The *semicircular* canals are supposed to arrest sonorous undulations after they have impressed the auditory nerve, the waves being transmitted through the ampullæ of each canal and meeting at their place of junction. In this respect, their function is analogous to that of the choroid coat of the eye, which absorbs the rays of light after they have impinged upon the retina, and thus prevents that delicate expansion from being unduly excited. The *cochlea*, is thought to enable us to judge of the pitch of notes, an idea which seems to derive confirmation from the corresponding development of this portion in animals; its function, however, is the same as that of the semicircular canals. The *vestibule*, from its uniform presence, may be considered as the essential part of the organ of hearing.

The chain of bones, it was said, connects the external and internal ear. The base of the stapes is attached to the membrane filling up

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the fenestra ovalis. Immediately beneath this is a circular opening, called the *foramen rotundum*, which also is filled up with a membrane, and is capable of receiving reciprocal vibrations from the air of the middle ear, and transmitting them to the internal ear.

The *vestibule* and *semicircular canals* have lying within them a *membranous labyrinth*, having the same general shape as the cavities in which it lies, only smaller. Between it and the walls of the bony labyrinth lies the fluid called the *perilymph*, and within it is contained the *endolymph*, and some small calcareous particles called *otolithes* or ear-stones. The use of the membranous labyrinth is probably to afford a more extended surface for the expansion of the auditory nerve. The *otolithes*, by being thrown into vibration, probably increase the impression upon the nerve.

The sonorous waves reach the labyrinth from the membrana tympani in three distinct ways. 1st. A portion of the vibrations reflected from the walls of the tympanum reaches the external wall of the vestibule immediately, this being at the same time the internal wall of the tympanum. 2d. Other vibrations are thrown directly upon the fenestra rotunda, and in this way reach the cochlea. 3d. A third set of vibrations travel along the chain of bones immediately from the membrana tympani to the labyrinth. This is the most powerful of any. The fluid of the labyrinth may also be thrown into vibration, by undulations transmitted through the bones of the head.

A single impulse communicated in any of the above ways is sufficient to excite the momentary sensation of *sound*, but a number of them in rapid succession is essential to the production of a *musical tone*. The *acuteness* or *depth* of the tone depends upon the rapidity with which the impulses succeed each other.

The acuteness of hearing varies very much in different individuals, and its power may be very much increased by practice. A part of this increase is due to the greater attention which its fainter indications receive; a part also to the increased use of the organ. A want of *musical ear* is an encephalic defect, and not a deficiency of the organ.

The power of appreciating the *direction* of sounds is for the most part acquired by habit. In some instances we are assisted by the relative intensity of the sensations communicated to the two ears respectively. The idea of *distance* is another acquired perception depending principally upon the *loudness* or *faintness* of the sound.

The sensation of sound often lasts longer than the exciting cause of it. It is upon this circumstance that the continuity of a musical tone depends; a fresh impulse succeeding before the impression of the first has disappeared.

The *subjective phenomena* of hearing generally result from some affection of the brain, or that part of it in which the auditory nerve is implanted. Ringing sounds, or buzzing in the ears, are the most common, and are indicative of either redundancy or deficiency of blood in the brain. They may also be caused by some disturbance of the local nutrition of the brain.

SENSE OF VISION.

By the sense of sight, we become acquainted with the existence of *light;* and by the medium of that agent, we take cognizance of the form, size, colour, position, &c., of bodies that transmit or reflect it. A knowledge of the laws of light and optics, is essential to an understanding of the functions of the different parts of the organ of vision; for these the student is referred to works on natural philosophy.

In the globe of the eye we recognise, as the most essential parts, the expansion of the optic nerve, called the *retina;* and in front of this the *transparent refracting media,* which transmit the light so as to bring it to a focus upon the nervous expansion. The optic nerve at its entrance into the eye splits up into numerous fibrils, which spread themselves out, and inosculate freely with each other, so as to form a net-like plexus. This plexus comes into relation with numerous vessels and a layer of ganglionic cells, like those in the cortical part of the brain. This layer of cells constitutes the internal layer of the true retina.

In order to protect the retina, the slightest change in whose form would be attended with injury to its function, the whole is enveloped in a dense tissue called the *sclerotic,* which is opaque, with the exception of its front, where it becomes modified to allow the light to enter, and is called the *cornea.* Between the sclerotica and the retina is a layer of dark pigment contained in a delicate membrane called the *choroid,* the use of which is to absorb the rays of light after they have made their impression upon the retina. In the albino it is entirely wanting, and in others it becomes gradually lighter in colour as they advance in life, so as to increase the stimulus applied to the retina, by reflecting the rays again from one part of its surface to another. In front of the retina are the *transparent media.* These are the *vitreous humour,* the *crystalline lens,* and the *aqueous humour.* The *vitreous humour* lies immediately within the cup formed by the retina, and seems destined to give it the necessary support inside, which the sclerotic gives outside. In the anterior part of the vitreous humour is imbedded the *crystalline lens,* which comes nearly up to the cornea in front, leaving a small cavity, however, which contains the *aqueous humour.* Across this cavity, and dividing it into an *anterior* and *posterior chamber,* hangs a vertical curtain-like process of the choroid, called the *iris.* This is perforated in its centre by a circular aperture called the pupil, which is capable of being enlarged or diminished; a condition permitted by the fluidity of the aqueous humour.[1] The contraction of the pupil under the stimulus of light, seems to be effected by a *sphincter muscle* surrounding the orifice of the pupil, and put in action by the third pair of nerves. This seems to be a pure reflex action, in which the optic nerve is the *afferent,* and the third

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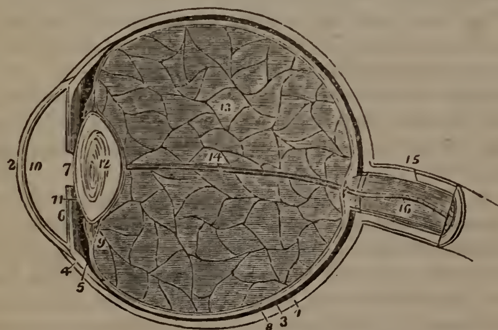
[1] Todd and Bowman.

pair the *efferent*. The stimulus is the presence of light. When the optic nerve is divided, the *fifth pair* may in some degree convey the requisite stimulus. The *dilatation* of the pupil probably results from the elasticity of the tissue of the iris after the muscular contraction has ceased. The iris prevents the ingress of too much light, and also shuts off the rays of light from falling on the circumference of the lens. The *transparent media* so refract and modify the rays of light, as to overcome both *spherical* and *chromatic aberration*, and bring them to a perfect focus upon the retina.

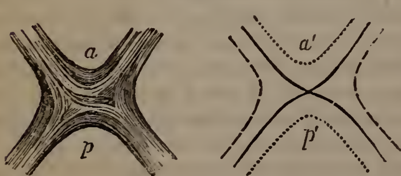
Fig. 208.



Longitudinal section of the globe of the eye. 1. Sclerotic. 2. Cornea. 3. Choroid connected anteriorly with (4) ciliary ligament; and (5) ciliary processes. 6. Iris. 7. Pupil. 8. Retina. 9. Canal of Petit. 10. Anterior chamber, containing aqueous humour. 11. Posterior chamber. 12. Crystalline lens. 13. Vitreous humour. 14. Neurilemma of the optic nerve. 16. Central artery of retina.

The *second pair of nerves* is devoted to the sense of sight, and is hence called *optic*. The greater part of their roots may be traced to the tubercula quadrigemina, which are regarded as the optic ganglia; from these they run forwards along the base of the brain, and unite in front of the tuber cinereum and mammillary bodies, forming an intimate junction called the *chiasm*. From this point they diverge, and enter the orbits through the optic foramina. Part of the fibres of each nerve pass to the opposite eye, part are commissural, and the remainder pass to the eye of the same side. (Fig. 209).

Fig. 209.



Course of fibres in the chiasm. *a*. Anterior fibres, commissural between the two retinæ. *p*. Posterior fibres, commissural between the thalami. *a′*, *p′*. Diagram of the preceding.

The eye has six muscles, four straight, the *recti;* and two oblique, the *obliqui.* The first are supplied by the third pair of nerves, except the rectus externus, which has the sixth. Of the latter, the superior oblique receives the fourth pair; the inferior, a branch of the third. When the *recti* act together, they fix the eyeball; when singly, they turn it towards their respective sides. The *oblique* antagonise the recti, and in addition, when acting together, draw the globe inwards, and converge the axes of the eye. The superior oblique turns the eye downwards and inwards, and the inferior oblique upwards and inwards. There is, however, considerable uncertainty as to their functions.

The adaptation of the eye to distances, by which a perfectly distinct image is perceived, whether the object be far or near, is a phenomenon as yet not explained. By some it is thought to be entirely educational; by others it is supposed to depend upon a varying length of the focal distances, produced either by altering the shape of the globe of the eye, so as to diminish or increase its convexity, or by altering the position of the lens by muscular agency. It is interesting to remark, that the adjusting power of the eye is lost or greatly impaired by the extraction of the lens, or by paralysing the ciliary and iridial muscles by belladonna. According to Dr. Clay Wallace, the ciliary muscle advances the lens, by compressing the veins, and thus causing an erection, or lengthening of the ciliary processes. The contraction of the iris, which takes place when the eyes converge, is supposed to depend on the third pair, which is distributed to it and the internal recti.

The forms of imperfect vision, known as *myopia* and *presbyopia*, are to be attributed entirely to defects in the optical adaptation of the eye. In *myopia*, or *near-sightedness*, the refractive power of the eye is too great, and the rays of light are brought to a focus before reaching the retina. This defect is to be corrected by a double concave lens which shall *disperse* the rays, and thus overcome the too great convergence. In *presbyopia*, or *far-sightedness*, there is the opposite defect, there is not sufficient refracting power, and the rays reach a focus behind the retina. This defect is to be obviated by convex lenses, which increase the refracting power of the eye. Myopia, which commonly occurs in young persons, is not always corrected by age. The presbyopic eye is always present after the operation for cataract.

It is known that the rays of light from the opposite points of a luminous object, by reason of the changes they undergo through the successive refractions which they experience, cross one another, and thus the image on the retina appears inverted. The question then arises, how do we see objects *erect*, with an *inverted* image on the retina? Volkmann has shown, that Sir D. Brewster's law of visible direction, which affirmed that every object is seen in the direction of a perpendicular to that point of the retina on which the image is

formed, and that as all these perpendiculars meet in the centre of the eye, the line of direction is identical with the prolonged radius of the sphere, is not optically correct. Some of these lines cross each other at a point behind, and some before the lens, and they thus fall on the retina at such different angles, that no general law can be laid down respecting them. The notion of erectness, which we form by the combined use of our eyes and hands, is really the result of intuitive perception.

Single vision with two eyes, is explained by the fact that the rays of light proceeding from a luminous object fall upon parts of the retina which are *accustomed to act together.* It is not necessary that these points should be equidistant from the optic nerve, as is evident in strabismus. Double vision almost always follows the operation for its cure, till the parts become accustomed to act together.

The vanishing of images that fall on particular parts of the retina, as shown in Marriotte's experiments, is due to the fact that the rays fall directly upon the centre of the optic nerve, at the point where the middle artery of the retina passes in; and as this has no special sensibility, no impression, of course, is conveyed to the brain.

By the association of visual and tactual sensations, we obtain knowledge of various properties of bodies, such as smoothness and roughness, form, and to a certain extent, of distance. In the latter both eyes seem to be required. The distinctness of outline also assists us in the estimate of distances, haziness of outline being generally associated with distance. If we know the *real* size of an object, we often judge of its distance by its *apparent* size.

Impressions made upon the retina continue for some time after the removal of the stimulus. It is this which causes the appearance of *a circle* of light when an ignited point is rapidly moved in a circle. It also accounts for the optical delusion in the toy known as the thaumatrope.

The phenomena of *accidental colours* is thus explained. When the eye is steadily fixed for a length of time upon one particular colour, as for instance, upon a red wafer, the retina becomes fatigued, and loses its impressibility to that colour; if now the eye be turned to a white ground, a spot having a different colour will be seen; this will be made up of all the colours of the solar spectrum, *minus the red,* and the resulting one colour is called the *complementary* or *accidental colour.* In this case it will be bluish-green. The laws of harmonious colouring in painting, are founded upon the combination of complementary colours.

The subjective phenomena of vision are familiar to all. Examples are seen in the flashes of light before the eyes in congestion of the brain; and that also result from blows that jar the optic nerve or ganglia.

The mal-appreciation of colours, like the deficient musical ear, is rather an encephalic defect, than in any way connected with the visual organ itself

THE ENCEPHALIC NERVES.

The only encephalic nerves whose functions have not been alluded to, are the *fifth; portio dura* of the *seventh;* and the *eighth pairs.* The *fifth* and *eighth pairs* combine the functions of *sensitive* and *motor* nerves. The *portio dura* is entirely *motor.*

The *fifth pair* presents a remarkable resemblance to the spinal nerves in its mode of origin. It arises by two roots, a larger and a smaller; the larger is involved in ganglion, and the two are quite distinct until after the formation of the ganglion. The trunk of the nerve separates into three branches, the *opthalmic,* the *superior maxillary,* and the *inferior maxillary.* The first two consist exclusively of fibres derived from the posterior or larger root and ganglion; the third is composed of fibres from both roots: it is the only portion that is strictly compound (Fig. 210.

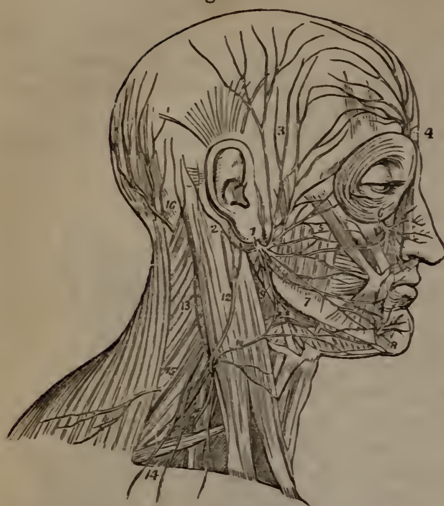
Fig. 210.

A view of the distribution of the fifth pair. 6. First branch of the fifth pair or ophthalmic. 7. Second branch or superior maxillary. 8. Third branch or inferior branch. For other reference, see Anatomy.

The ophthalmic and superior maxillary being composed of fibres from the posterior root, are exclusively *sensitive.* The inferior maxillary is both *motor* and *sensitive.* The opthalmic and superior maxillary are distributed entirely to sentient surfaces; division of them, therefore, destroys the sensibility of those parts, without impairing the muscular action. The inferior maxillary sends some branches and motor filaments to the muscles of mastication; the others go to the integuments of the lower part of the face, and the mucous membrane of the mouth and tongue, which they supply with general sensibility. Division of these last destroys the general sensibility in the parts to which they are distributed, and also puts a stop to the movements of mastication. Painful affections of the face (neuralgia) have their seat in the sensitive branches of this nerve.

The *portio dura* of the seventh pair is the *general motor* nerve to the face, (Fig. 211.) The muscles supplied by it are chiefly those upon which the aspect of the countenance and the balance of the features depend. It is sometimes called the *nerve of expression.* The acts of closing the eyelids and frowning depend on this nerve. Sub-

Fig. 211.



Distribution of the facial nerve. 1. Facial nerve escaping from stylo-mastoid foramen. For references, see Anatomy.

sequently to its entrance into the canal from which it emerges, it receives sensory filaments from the fifth, and some cervical nerves, which cause irritation of its several branches to produce pain. Section of the nerve, at its point of emergence from the stylo-mastoid foramen, is followed by paralysis of the muscles of the face and eyelids.

It was formerly thought to be the seat of *neuralgia*, and was upon several occasions cut. The only result was *paralysis of that side of the face, total loss of control over the features, of the power of frowning, and of closing the eyelids.* The portio dura is also the channel of the reflex movements concerned in respiration, but it is not at all concerned in mastication.

The *eighth pair of nerves* is made up of three others, the *glosso-pharyngeal*, the *par vagum* or *pneumogastric*, and the *spinal accessory* (Fig. 212). The conclusions that have been arrived at by physiologists in relation to these nerves, can alone be stated here.

The *glosso-pharyngeal* is the *sensitive nerve* of the mucous membrane of the fauces and of the root of the tongue, and in the latter situation it ministers to taste and touch, as well as to common sensibility; and being the sensitive nerve of the fauces, it is probably concerned in the feeling of nausea so readily excited by stimulating the mucous membrane of this region. Such are its peripheral organization, and central connexions, that stimulation of any part of the mucous membrane in which it ramifies, excites instantly to contraction all the faucial muscles supplied by the vagus and the facial nerves, and the permanent irritation of its peripheral ramifications, as in cases of sore throat, will affect other muscles supplied by the facial nerves also. It is, therefore, an *excitor* of the movements necessary to pharyngeal deglutition.

The *par vagum.*—The following conclusions may be adopted respecting the functions of this nerve and its branches.

1. That the vagus nerve contains filaments both of *sensation* and *motion.*

2. That its pharyngeal branches are *motor.*

3. That its superior laryngeal branch is the *sensitive* nerve of the larynx, containing a few motor filaments to the crico-thyroid muscle.

4. That the inferior laryngeal is the principal *motor* nerve of the larynx.

5. That the cardiac branches exert a slight influence on the movements of the heart.

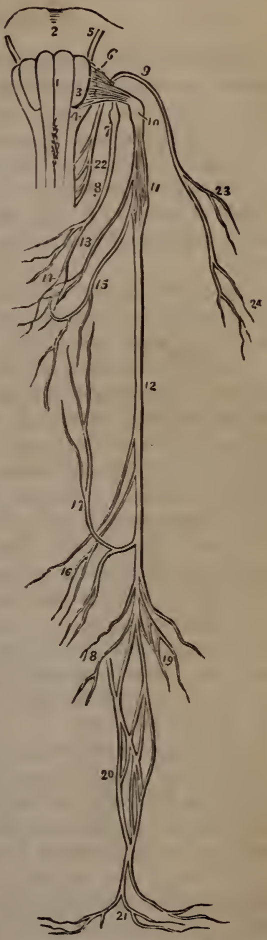
6. That its pulmonary branches contain both *motor* and *sensitive* filaments, and exercise an important influence upon the respiratory acts, for they cannot be destroyed without retarding materially the respiration, impeding the passage of the blood through the lungs, and causing œdema of these organs.

7. That the œsophageal branches are the channel through which the muscles of that tube are excited, through the medulla oblongata, to contract.

8. That the gastric branches influence the movements of the stomach, and probably in some degree the secretions and the sensibility of its mucous membrane; but that their integrity is by no means essential to the continuance of the secretion, or to complete chymification. (Todd and Bowman.)

The *spinal accessory* is so called in consequence of its extensive connexion with the upper part of the spinal cord. Of its two branches, the *internal* is probably *sensitive.* The *external* is distributed to the *sterno-cleido-mastoideus* and *trapezius* muscles, some of its filaments inosculating with the cervical plexus, and is *motor* in its functions. The movements excited by irritating it are of a direct, and not of a reflex character.

Fig. 212.



Origin and distribution of eighth pair of nerves. 6. Origin of the glosso-pharyngeal nerve. 8. Trunk of the nerve. 9. Spinal accessory. 10. Ganglion of the pneumogastric. 22. Origin of the spinal accessory.

MUSCULAR MOTION.

The muscular system forms part of the apparatus of animal life, inasmuch as it is the instrument by which nervous energy operates upon external objects. The contractility which it manifests on the application of a stimulus, is an endowment derived from its own structure, and not from the nervous system. The presence of this contractility is connected with the healthy nutrition of the tissue, and with its due supply of arterial blood; the separation of any muscular part from its nervous connexions has none but an indirect influence on its properties.

The development of muscles, their physical and vital properties, their mechanical adaptation as moving agents, having been already described (pages 235, 236), but little remains to be added.

There is one form of *contractility* which produces a *constant* tendency to contraction in the muscular fibre, but which differs from simple elasticity from the fact that it exists after death and before decomposition takes place. This is called *tonicity*, and it manifests itself in the separation or retraction that takes place between the divided ends of a living muscle, as in amputation. It also shows itself in the permanent flexure of the joints when the extensors are paralysed, as in lead palsy. In the healthy state the tonicity of the several groups of muscles is counterpoised, but the balance is destroyed when the tonicity of one set is lost or impaired.

The tonicity is greater in the non-striated than in the striated; it is this property that keeps the walls of the arteries contracted upon their contents. It is increased by cold, and diminished by heat. The *rigor mortis*, as already described, is probably to be regarded as a manifestion of this property.

The *energy* of muscular contractions is seen in the various feats of strength performed by jugglers, &c. It is very much increased by continued exercise. Much, however, depends upon the mechanically advantageous application of the power; persons of ordinary strength may in this way perform feats that would seem incredible.

An idea of the *rapidity* of muscular contractions may be had by estimating the number of letters that can be pronounced in a given time. Some persons can pronounce 1500 in a minute; each of these requires a separate contraction of muscular fibres, followed by a relaxation of equal length. Each contraction must therefore have occurred in one-tenth of a second.

The production of *Voice*, or vocal sounds, depends upon the application of muscular power to the vocal instrument, and is therefore properly considered under this head.

OF THE VOICE AND SPEECH.

The voice is produced when the air is expelled from the lungs; every one knows it is impossible to articulate sounds with the mouth and nose closed. It must be remembered that vocal sounds and speech are two very different things; the former may be produced in great perfection, where there is no capability for the latter. The voice is formed in the larynx; the modifications of it by which speech is formed, are effected in the cavity of the mouth. The natural voice, or *cry*, exists in nearly all animals. Man alone, it is believed, has the power of producing articulate sounds or *language*.

The larynx consists of four cartilages. The *cricoid*, the *thyroid*, and two *arytenoid*. The *cricoid* is the lowest of these; it surmounts the trachea, and is shaped like a seal-ring, having its deepest portion behind. The thyroid is situated above the cricoid, with which it is articulated by its lower cornua, in such a manner that its lower front margin may be made to approach or recede from the upper margin of the cricoid. The higher the tone, the more nearly do they approximate. The *arytenoid* cartilages are situated upon the posterior and superior portion of the cricoid, with which they are articulated also in a moveable manner. From the tips of the arytenoid cartilages, to the inner front of the thyroid, are stretched the two pairs of vocal ligaments, composed of yellow elastic tissue, and named the *superior and inferior vocal ligaments.* The whole inferior surface of the larynx is lined by mucous membrane, which is reflected over the vocal cords, dipping down into the spaces between them to form the *ventricles of the larynx*, or, as they are sometimes called, the ventricles of Morgagni, or of Galen (Fig. 213). Upon the varying degree of tension of the vocal ligaments depends the variety of tones of which the voice is susceptible. For the production of vocal tones the ligaments of the opposite sides are also required to be brought into approaching parallelism with each other, by the approximation of the points of the arytenoid cartilages, whilst in the intervals they are separated from each other, and the *rima glottidis*, or fissure between them, assumes the form of the letter V (Fig. 214).

The muscles that are concerned in governing the pitch of the notes, by regulating the tension of the cords, and those that govern the aperture of the glottis, are the following. (The table is modified from Carpenter's Human Physiology.)

GOVERN THE PITCH OF THE VOICE.

Antagonists.	*Crico-thyroidei*, *Sterno-thyroidei*,	Depress the front of the thyroid cartilage on the cricoid, and *stretch* the vocal ligaments; assisted by the arytenoideus and crico-arytenoidei postici.
	Thyro-arytenoidei, *Thyro-hyoidei*,	Elevate the front of the thyroid cartilage, and draw it towards the arytenoid, *relaxing* the vocal ligaments.

GOVERN THE APERTURE OF THE GLOTTIS.

Crico-arytenoidei postici, *Arytenoideus,*	*Close* the glottis.
Crico-arytenoidei laterales,	*Open* the glottis.

The muscles that relax or stretch the vocal ligaments are concerned in voice alone. Those that govern the aperture of the glottis are also concerned in respiration, regulating the amount of air received. They

Fig. 213.

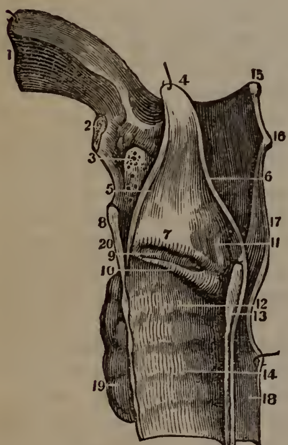


Fig. 214.

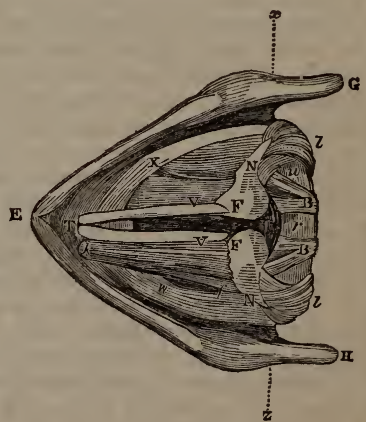


FIG. 213.—Vertical section of the larynx to show its internal surface. 7. Superior vocal ligaments. 8. Section of thyroid cartilage. 9. Ventricle of Galen. 10. Lower vocal ligament. 11. Arytenoid cartilages. 12. Inside of cricoid cartilage.

FIG. 214.—Larynx from above. G. E. H. Thyroid cartilage. N. F. Arytenoid cartilages. T. V. T. V. Vocal ligaments. N. X. Crico-arytenoideus lateralis. V. *k. f.* Right thyro-arytenoideus. N. *l.* N. *l.* Crico-arytenoidei postici. B. B. Crico-arytenoid ligaments.

are also the seat of the spasmodic affections of the larynx which so often occur in children.

The vocal apparatus has been compared to various instruments, such as *stringed instruments*, *flutes*, and *reed instruments*. It is not justly compared to a stringed instrument, inasmuch as the cords are too short to produce all the varied notes of which the human voice is capable, more especially the lower notes. Besides which they are covered with mucous membrane, which would act effectually as a damper upon them.

Neither can they be compared to a flute pipe, in which the sound is produced by the vibration of the column of air contained in the tube, and the pitch of the note determined by the length of the column,

slightly modified by its diameter. There is nothing in the form or dimensions of the column of air between the larynx and mouth which can be conceived to render it capable of such vibrations as are required to produce the tones of the human voice.

The third class of instruments are the *reeds*, and to these the vocal organ bears more analogy than to any of the others. In the reed instrument, a thin plate or lamina vibrates freely in a frame that allows the air to pass readily round it. In the accordion the variations in the tone are produced by different lengths in the reeds. In the vocal apparatus there are laminæ formed by stretching the mucous membrane over the vocal ligaments, and by increasing or diminishing the tension of these, various notes can be produced. In this respect it resembles a reed instrument. In regard to the production of falsetto notes nothing certain is known. Müller supposes that in them merely the border of the glottis vibrates. The idea of MM. Diday and Petrequin, that in the production of falsetto notes, the vocal cords are not thrown into vibration, but are fixed and tightened, so as to resemble the "mouth orifice" in the flute, while the column of air is thrown into vibration, as in that instrument, appears most reasonable.

The *intensity* of the voice, or, as it is commonly called, the *volume* of the voice, results in part from the force with which the air is driven from the lungs, and from the size of the thoracic cavity; and in part from the facility with which the vocal cords and other parts of the larynx are able to vibrate. These modifications explain the difference which exists between the male and female voices. The vocal cords in the male are longer than in the female in the proportion of 3 : 2, and their voices are commonly an octave lower.

The power of the will in determining the exact degree of tension necessary to produce a given note, is extremely remarkable. The natural compass of the voice in most persons is two octaves or 24 semitones. Now a singer can produce ten distinct intervals between each semitone, or 240 intervals. There must, therefore, be 240 different states of tension of the vocal cords all producible at pleasure when a distinct conception exists as to the tone required. And all these different notes can be produced without a greater variation in the length of the vocal cords than one-fifth of an inch.

The peculiar *timbre*, or *quality* of the voice, which each person possesses, and its imperfections, depend on the smoothness or roughness of the cartilages of the larynx, or on the different aptitudes for vibration which the parts of the organ possess.

In the production of voice the *inferior ligaments* are the important agents. If we remove the superior ligaments, voice continues, though more feeble; but if we divide the inferior ligaments, voice is destroyed. Even the ventricles of the larynx may be cut into, and yet voice continue. The use of the ventricles is to allow free vibration of the vocal laminæ.

All the articulated tones or sounds which form the basis of speech are produced under the conjoint influence of the larynx, fauces, and mouth. In the majority of instances, the whole, or the greater number of the organs included in the mouth, co-operate in producing each articulate sound. The vowels alone are primarily formed between the vocal chords, and are continuous sounds, modified by the shape of the aperture through which they pass out. The sound of consonants is formed by some kind of interruption to the voice, so that they cannot be properly expressed unless joined with a vowel. It is the latter which commonly offer the greatest difficulty to the stammerer, especially those which are called *explosive.*

HAND-BOOK

OF

SURGERY:

WITH

SIXTY-EIGHT ILLUSTRATIONS.

CONTENTS.

SURGERY.

INFLAMMATION.

THE definitions of inflammation vary with different authors. That of Miller is as satisfactory as any other. He defines inflammation to be "a perverted condition of the blood and blood-vessels of a part, interrupting its healthful function, and changing its normal structure; ordinarily attended with redness, pain, heat, and swelling; and inducing more or less disturbance of the general system." The term should be limited to processes *essentially morbid.*

The transition from health to inflammation may be divided into three stages: 1. Simple vascular excitement; 2. Active congestion; 3. True inflammation.

1. *Simple vascular excitement.*—When any irritant is applied to the skin, an impression is produced through the nervous system which is manifested particularly in the blood-vessels.

At first the blood circulates with great rapidity, although the small arteries and capillaries are of diminished calibre. Afterwards the vessels yield and are dilated, and an increased quantity of blood circulated with great rapidity, with a tendency to serous and plastic exudation. The function of the part is exalted, and this may be manifested by excessive nutrition or secretion. This is simple vascular excitement.

2. *Active Congestion.*—More blood is sent to the part, and the capillaries and minute arteries begin to give way under the increased pulsation of larger arterial trunks; by over-distension, the vascular coats lose their tonicity. "And partly from this cause, partly on account of change in the blood itself, which seems more viscid, with its corpuscles less distinct, and, when examined by the microscope, is found especially to possess an increased number of colourless 'lymph globules,' unusually adhesive to each other, and to the walls of the vessel, and so manifestly operating obstructively—and partly, also, it is probable, from an increase of vital attraction between the blood and surrounding parenchyma—the circulation loses its acquired rapidity, and becomes slower even than in health. The red corpuscles are no

longer limited to the central current, but are encroaching more and more on the lateral and clear 'lymph spaces.' Exudation is more copious than in the previous stage; it consists of serum and of liquor sanguinis, the latter usually predominating: and when the action has been for some time sustained, and as it were, established in the part, fibrin alone may be deposited." "The natural function of the part is not simply exalted, but begins to be perverted, for example, secretion is not only increased, but changed in its character." Nutrition is becoming more and more disturbed,—this is the commencement of diseased action. "This action may resolve after the removal of its simple exciting cause; or it may be sustained for some time, as in the healing of wounds, and the closing of ulcers; or it may advance to

"3. *True Inflammation.*—The change which, in the preceding stage, had begun in the blood, is now completed. The over-distension of the capillaries is established; the capillary power is for a time gone, perhaps in consequence of diminution or actual suspension of the nervous influence; and the coats of the capillaries and other vessels are thickened, softened, and impaired in cohesion, being themselves the subjects of structural change. The languor of circulation approaches stagnation, and at some points this has actually occurred; every part of the distended capillaries is occupied by crowded coloured and colourless corpuscles; partly, it may be, from increased attraction between the former and the surrounding parenchyma, partly by accumulation and adhesion of the latter to each other and to the capillary walls. The altered liquor sanguinis is exuded in profusion. The capillaries also give way in their coats, and from the lesion, blood is extravasated in mass. Suppuration is in progress by extravascular degeneration of the fibrinous effusion, or else by a secretive elaboration of it ere yet it has left the vessel. Breaking up and disintegration of texture ensue, according to the extent of extravasation and suppuration; and the disintegrated texture is commingled with the effusion. The formative power has ceased, and the opposite condition, a tendency to disintegration, from diminution of vitality, has become established. Disorder of function is complete; secretion, for example, being in the first place arrested, and when restored, more vitiated than before."

The *local symptoms* are redness, swelling, heat, pain, throbbing, increased sensibility, disorder of function, arrest and change of secretion.

Redness.—This is due to an afflux of blood to the part; the vessels become distended, and the capillaries convey red blood; the proportion of the red globules is also increased by the exudation of the serum. The *degree* varies in different tissues, and according to the intensity of the action; compare, for instance, an inflamed tendon with an inflamed mucous membrane. The *tint* varies also between a bright scarlet and a deep purple. *Permanency* is characteristic of inflammatory redness. The redness of blushing is not indicative of inflammation, because it is momentary, and not conjoined with other symptoms.

Swelling. — This is occasioned by the increased quantity of blood, and an effusion of serum, pus, &c. The swelling of inflammation must be conjoined with other symptoms also, for in œdema there is swelling, but not inflammation. It must be *gradual* in its development: the sudden swelling produced by a hernia or dislocation is not that of inflammation. It must also be recent, not like the tedious growth of a genuine tumour. Swelling may be injurious, as in the brain or orbit of the eye; or it may be useful, as in a fracture, &c. It is most remarkable in loose textures; also in the breast, testicles, and lymphatic glands.

Heat. — This depends upon a more rapid oxidation of the tissues, which are also supplied with an increased quantity of blood. Heat of inflammation may be partly actual, as ascertained by the touch or the thermometer, and partly the result of a perverted nervous function, estimated only by the patient. It must be permanent, and conjoined with other symptoms to be characteristic, for in hectic there is burning of the hands and feet, yet no inflammation is there.

Pain.—Is caused partly by the pressure upon the nerves of the inflamed spot, and the distension of the arteries which are supplied by small nerves; and partly by disordered function. Mechanical pressure increases it, for instance, by the hand in peritonitis, or inspiration in pleurisy. Pain varies with the natural sensibility of the part affected, hence inflammation of the skin is more painful than that of cellular tissue. It is proportionate to the yielding nature of the structure affected; thus inflammation produces more pain in bones and ligaments, than in mucous membrane.

Pain is not always indicative of inflammation — for example, in spasm and neuralgia. In spasm the pain comes on suddenly, and is relieved by pressure; in neuralgia it is intermittent. Not so with inflammation—in the latter the pain gradually increases from the first; if it suddenly disappears suspicion is excited lest gangrene has supervened. Pain may be sympathetic, and referred to a part at a distance; in coxalgia, the pain is at the knee; in liver disease, in the shoulder; in disease of the kidney, at the orifice of the urethra. This is a point of practical importance in the application of remedies.

Increased sensibility. — This may be illustrated by intolerance of light when the eye is inflamed; the tenderness of the skin in erysipelas; the rejection of food by the stomach, and the constant urination if the bladder is the seat of inflammation.

Disorder of function. — The stomach cannot digest, nor the kidney secrete. If the brain or spinal cord be the seat, we may expect convulsions, or paralysis.

The *causes of inflammation* may be divided into *predisposing* and *exciting.*

Predisposing causes. — Include sanguine temperament, excitability; plethora, excess in food, drink, or exercise; debility, miasmata,

bad air, food, and clothing; previous disease, &c. These may be considered as constitutional or idiopathic.

Exciting causes. — May be *direct*, such as the chemical effects of acids, salts, &c.; or mechanical effects of wounds, pressure, &c. *Indirect*, or vital, such as heat and cold, cantharides and turpentine. *Specific*, as in the instance of vaccine virus.

The *duration* and *character* of inflammation are modified by the nature, situation, and condition of the part affected, and the temperament and diathesis of the patient. Age, sex, habit, atmosphere, and season, all exercise an important influence in its progress and type.

RESULTS OF INFLAMMATION.

1. *Resolution.*—This is the most favourable result. It is the restoration of the part, as regards both structure and function, to its original and normal state. Effusion takes place, the vessels are relieved, the red globules move on, absorption takes place, and the usual symptoms subside. *Delitescence* is the *sudden* disappearance of inflammation; and when it is attended by the establishment of a new one, the term *metastasis* is used.

2. *Excessive deposit.*—Either of serum or fibrin, which has exuded through the coats of the vessels. When *serum* is effused into cellular tissue it constitutes *œdema*, which is characterized by *pitting* on pressure; when effused and collected in serous membranes, it constitutes *dropsy*. The effusion of fibrin requires a higher degree of inflammation, upon the subsidence of which new structures are formed by the organization of the fibrin, and parts are repaired; hence the term plastic is applied to it. Thus, wounds unite, bones knit, and arteries consolidate.

3. *Hemorrhage.* — Occasioned by the destruction of the coats of the vessels. If it occur in the interior, it is termed extravasation. It is usually injurious, by producing pressure and exciting irritation; as, for instance, in the humours of the eye, or membranes of the brain.

4. *Suppuration.*—The formation of a fluid called pus. It is called *laudable* when it is yellow, creamy, and opaque; insoluble in water, but readily mixing with it. It has no odour, but a slightly sweetish taste. It is not corrosive, but bland and protective to tender granulations until covered by cuticle. When confined, it produces disintegration of the textures in contact, by pressure. It is the result of a vital action. It consists of a fluid and globules. The fluid is the liquor sanguinis of blood effused; this separates into serum and fibrin; the fibrin becomes granular by the formation of exudation corpuscles, and these degenerate into pus-globules. When pus is thin and acrid it is termed *ichor*, consisting mostly of serum. In scrofulous persons it is flaky. When it contains blood it is called *sanies*. When it is of a leaden colour, thick, coagulated, and very offensive, it is *sordes*. Sometimes it is mixed with a subtle virus, as the venereal or vaccine;

it is then said to be *specific*. When mixed in the mucous or serous discharges, it is termed sero-purulent or muco-purulent.

When suppuration is profuse and long-continued, in a debilitated frame, it produces a fever called *hectic*, which is a constitutional irritation different from the inflammatory type. It is remittent, and attended with paleness of surface, except upon the cheeks. The appetite is good, but yet there is great emaciation. The tongue is clean, at first moist, but afterwards dry and glazed or aphthous. The bowels are constipated, or else attended with a diarrhœa, termed colliquative. The palms and soles burn, and there is great thirst. Respiration is rapid and short. The pulse is frequent and small. At noon there is increased fever preceded by a chill; at night there is perspiration, most profuse towards morning. The eyes are bright, though sunk in hollow orbits; and though there may be sleeplessness, lassitude, and debility, yet the mind is clear and the spirits are good.

5. *Ulceration.*—Hunter supposed that it was entirely the result of absorption. But it is also due to a vital softening of a texture changed by inflammation and suppuration; becoming disintegrated and fluid, it is partly absorbed, and partly passes away with the pus. The more violent the inflammation, the more rapid is the destruction; the term phagedenic is applied to those ulcerations in which the part is apparently eaten or consumed with unusual rapidity. Congestion is a predisposing cause of ulceration. The skin, mucous membranes, and cellular tissue, yield more rapidly in ulceration than the vascular, nervous, and fibrous tissues. Those of intemperate habits, and of scrofulous or syphilitic taint, are most liable to its ravages. The parts most likely to be affected are those whose circulation is weak and languid, such as the lower extremities, and parts newly formed, such as cicatrices, callus and tumours.

6. *Mortification.*—This term includes the dying and death of a part from injury or disease. *Gangrene* denotes the process of dying, and is recognised by the following signs. Redness is changed into a livid hue; circulation is arrested, so is effusion, and there is less tension. Pain and heat abate, often suddenly. Putrescence commences, and there is an offensive smell. Phlyctenæ, or vesicles filled with putrid serum, appear over the skin. *Sphacelus* is the completion of the gangrene. The part is cold and insensible; shrunken, soft, and flaccid; crepitates distinctly, owing to its containing gas, the result of putrescence; vital action has ceased, and the colour becomes black if the parts are exposed to the air. A *slough* is a small sphacelation. Nature makes an effort to throw off an injurious mass. The living par in contact with the dead inflames; and, in consequence, the abrupt livid line is bordered by a diffuse, red, and painful swelling—the *line of demarcation*; this vesicates, the vesicle bursts, puriform matter is discharged, and an inflamed and ulcerating surface is disclosed—the *line of separation*. The furrow deepens; skin and cellular tissue yielding first, the tendons and arteries resisting for some time. No hemorrhage occurs during gradual division of the parts; the arteries

are sealed by the effusion of fibrin during the inflammation. But when the mortification is rapid, as in acute hospital gangrene, arteries are found playing in the dark and putrid mass alive, whilst all is dead around them. At length they yield, and death is hurried on by hæmorrhage.

The *constitutional symptoms* are of a typhoid form. The pulse is frequent and small, irregular or intermittent. The countenance is anxious, the face livid, the nose pinched, and the lips contracted.

Anxiety is soon changed into stupidity of expression, as if the patient were under the influence of opium or alcohol; sighing, hiccup, and involuntary movements of the hands and fingers are now observed, such as picking and fumbling with the bedclothes. Appetite fails; the tongue is coated with a brown fur, except at the tip and edges. The lips and mouth are dry and incrusted; swallowing is difficult. The mind is stupid, wavering, and subject to illusions; the articulation is thick and broken. Still more marked are the deathlike coldness, the clammy sweat, the small, indistinct, and flickering pulse, and the cadaverous expression. In this state a patient will sometimes lie for hours, and die without a struggle.

Mortification may be *acute* or *chronic*. The acute comprehends the humid, inflammatory, and traumatic. The chronic—the dry and idiopathic.

The *cause* of mortification is a *want of vital power*, and may be the result of high inflammation, mechanical injury, pressure, heat, obstruction to the return of venous blood, deprivation of nervous agency, interruption to arterial supply, as by aneurism or tourniquet, cold, general debility, bed-sores, improper food, spurred rye.

TREATMENT OF INFLAMMATION.

The first object is always to remove the cause, and afterwards to prevent or diminish the inflammatory action. The chief means are termed antiphlogistic, and consist of

General Bloodletting.—This is only required when the inflammation is severe, and when important organs are involved, such as the lungs, bladder, kidney, eye, and peritoneum. If resorted to unnecessarily, it produces congestions, effusions, and atrophy. *Syncope*, or fainting, is produced when bleeding is pursued to a great extent. It is occasioned by the removal of the natural stimulus of the heart—the blood, and by the sedative influence transmitted from the brain, when deprived of its share of arterial blood. The benefit to be derived from bleeding is not merely the loss of superabundant blood, but also the sedative influence, whereby the emptied capillaries can resume their natural tone. A rapid, full stream from a large orifice will soon produce syncope, if the patient be sitting or standing; whereas the system may be almost drained of blood by a slow stream from a small aperture, before faintness ensues, if the recumbent position is maintained. Bleeding is not to be regu-

lated by its *amount*, but by its *effects*. As a general rule, the blood should flow until there is some paleness of the lips, sighing, nausea, fluttering of the pulse, or relief of pain. The ability to bear bleeding will vary according to age, sex, temperament, and disease. A man in health will faint usually from the loss of fifteen ounces; the same person, with a severe inflammation, particularly of the head, will bear double that amount. *Reaction* takes place after bleeding, the pulse rises, and pain increases, often to such an extent, as to require a second amount to be taken. A smaller quantity will now produce the same effects as a large one in the first instance. The operation is usually performed at the bend of the arm, in the neck, or in the anterior temporal artery.

Local Bleeding. — This is preferable when the inflammatory action is not high; when the powers of the system are low, when the inflammatory action on the part has been fully established, and there would be no benefit from a general bleeding, and when extreme age forbids it.

Cupping. — By this means blood is obtained more rapidly than by leeches, and we have the advantage of general bleeding combined with local abstraction.

Leeching. — Leeches can be applied where cups cannot. In order to apply them, the part should be first washed, and if they will not stick, a little cream or blood should be smeared on it. Their appetite is increased by being dry. If slow to bite, immersion in warm porter will be useful. Their bites are sometimes troublesome from hæmorrhage. This is arrested by the mur. tinct. ferri, or a fine point of nitrate of silver. American leeches will draw a ʒ or ʒiss of blood; foreign leeches take an ʒ or ʒiss. Salt will occasion them to drop off.

Purgatives. — They deplete, by causing an increase of mucous exhalation from the bowels. They also act as derivant, prevent assimilation of nutrition, and promote absorption; they are particularly useful in diseases of the head, but are contra-indicated in bad fractures, and inflammatory affections of the bowels.

Emetics, *diaphoretics*, and *diuretics* are useful at the outset, emptying the stomach, and promoting perspiration, particularly the tart. ant. et potassæ.

Mercury. — Not only as a purge, but gradually introduced into the system, it seems to exert a tonic effect on both the extreme blood-vessels and the lymphatics; that is, in the absorbents, thus preventing or limiting impending effusion, and at the same time expediting the removal of that which had already been exuded.

Opium. — Particularly useful when combined with calomel, and given after bleeding. Before bleeding it arrests secretion, and stimulates, — afterwards it soothes the nervous system, relieves pain, and prevents reaction.

A strict *diet* must be maintained, and the drink should be refri-

gerant, at the same time both body and mind should be at rest, and there should be a good supply of fresh air.

Local Remedies.—Complete *rest* of the inflamed part. Elevated *position*, so as to favour the return of blood. *Cold applications*, ice-water, solution of sugar of lead, and muriate of ammonia—especially in the early stages; for in high inflammations *warmth* and *moisture* are very grateful to some persons—relaxing tension, and assuaging pain. *Nitrate of silver* has great antiphlogistic powers, as well as caustic properties, especially when applied to the skin and mucous membranes. Iodine also exerts a somewhat similar influence.

Counter-irritation.—By means of dry cupping, blisters, setons, issues, caustic, and actual cautery.

ABSCESS.

An abscess is a collection of pus in a natural or preternatural cavity, and may be either acute or chronic.

ACUTE ABSCESS.

Is frequently called *phlegmon*, when occurring in the subcutaneous cellular tissue. Commencing with all the symptoms of inflammation, —fever, pain, redness, and swelling. The centre is firm, with œdema surrounding it. The formation of pus is indicated by rigors, an abatement of the fever, and a feeling of weight, tension, and throbbing. The centre softens, which is termed *pointing*, and *fluctuation* can be felt. There is a natural tendency to the discharge of pus, which is more apt to be towards the skin. It is less apt to open into serous than into mucous membranes. The matter having been discharged, the pyogenic membrane lining the cavity becomes covered with numerous small, red, vascular eminences, called *granulations*. They are formed by the organization of lymph.

The cavity contracts and fills up with granulations. A white pellicle extends from the circumference, gradually covers the whole surface, and becomes organized into a new cutis and cuticle, called a *cicatrix*. At first the cicatrix is thin, red, and less vascular; it afterwards contracts and becomes paler.

The causes of abscess are mostly idiopathic; it occurs frequently after fevers; it may, however, be caused by blows, foreign bodies, &c.

Treatment.—The indications are, in the first stage to produce resolution, and prevent the formation of matter. After it has formed, the indications are to cause its evacuation, and induce granulation and cicatrization. There should be cold applications, and leeches applied to the part, purging, and low diet. When matter is formed, the applications should be warm fomentations and poultices. Poultices may be made of bread, Indian meal, or ground flaxseed softened with water; they should be large and light, and renewed frequently; they relax the skin, promote perspiration, soothe the pain, encourage the formation

of pus, and hasten its progress to the surface. Lint or spongio-piline soaked in warm water may answer for a substitute.

Abscesses need not be *opened* if they point, and are pyramidal, and do not enlarge in circumference, but may be allowed to burst themselves. But they should be opened when they are beneath tendons, fascia, or the thick cuticle; when caused by the infiltration of urine; when in loose cellular tissue, with a tendency to burrow; when near a joint, or under the deep fascia of the neck,—where it is desirable to obviate the scar made by the abscess opening spontaneously. The best instrument for the purpose is a straight-pointed, double-edged bistoury, by which the opening can be enlarged to any extent. The matter should not be forcibly squeezed out, but allowed to exude gradually into a poultice. By introducing a tent the edges are prevented from uniting.

Abscesses are sometimes absorbed, especially those in glandular structures and venereal cases. This can be promoted by leeches, mercurial ointment, and remedies adapted to increase the general health.

CHRONIC ABSCESS.

Is the result of a low degree of inflammation, and is often unsuspected. It is lined by a cyst, and the pus is serous or curdy. Sometimes the matter is concrete. Is most apt to occur in weak and scrofulous habits, and is usually free from pain, redness, swelling, &c. It may, however, become exceedingly large, and from distension, inflame, ulcerate, and discharge.

Treatment.—Improve the general health, and promote absorption by means of mercurial plasters, blisters, and iodine frictions. If it cannot be absorbed, it must be opened with care; a small, superficial abscess should be opened freely at once, the cavity injected with a stimulating solution, and pressure applied by means of compress and bandage. If the matter is not freely evacuated, great injury results from the effect of air on the contained pus; putrefying, the product—hydrosulphate of ammonia is absorbed, and the patient becomes typhoid. When the abscess is large, the opening should be small and valvular, so as to prevent the introduction of air; or, the opening may be healed after a portion of the matter has escaped, and another made ten days afterwards; or, the part may be kept constantly immersed in water.

ULCERS.

Ulcers are breaches of continuity of surface, the destruction being caused by disease or unrepaired injury. The following classification will be found to include the great majority of ulcers.

SIMPLE OR HEALTHY ULCER.

In this we have an exemplification of granulation and cicatrization. The surface is covered with a thick, creamy, yellow pus, not too profuse, and inodorous. The granulations are small, pointed, florid, sen-

sitive, and vascular. When they reach the level of the skin, cicatrization commences. The edge swells a little, and then is covered with a white pellicle of lymph, which is converted into cuticle.

Treatment.—The plan of the treatment is simply protective. Pus is natural to these granulations; if, however, it collects, it becomes a source of injury, increasing ulceration. The air acts as a stimulus, and may cause too great inflammation. Hence the propriety of dressing. It should be lint dipped in tepid water or some simple cerate; water dressings are now preferred. The dressing should only be removed for the sake of cleanliness and removing the fluid pus; but care should be taken not to wash the surface too freely, else the progress of cicatrization is delayed by the removal of lymph which may be mistaken for pus.

WEAK ULCER.

If the granulations are too luxuriant, becoming pale and flabby and long, they should be treated by an astringent wash, such as a solution of sulphate of zinc or copper; or they may require an escharotic, such as solid sulphate of copper or nitrate of silver; or a scab may be formed by exposure to the air, or spreading fine lint upon the surface; at the same time a generous diet will be beneficial.

SCROFULOUS ULCERS.

These occur in debilitated constitutions, and usually in clusters; most frequently upon the neck and joints. They originate in the cellular tissue, beneath the skin. At first, there is hardening, without pain, then swelling, followed by imperfect and slow suppuration; the skin becomes blue and thin, and the aperture for the discharge has ragged edges, revealing a dirty gray surface, with no granulations; the integument is soon undermined, and the ulcers communicate. The pain is slight, and the discharge is thin and serous. The system sympathizes and the result may be hectic.

Treatment.—Constitutional remedies should be steadily persevered in. Active measures must be taken to get rid of the soft infiltrated tissue surrounding, by escharotics; caustic potash must first be freely applied, and then a poultice; upon its removal a slough will be found to have separated, and the surface to be firm and vascular, covered with healthy granulations. The sore may then be treated as a healthy one, unless a relapse occur, when the application should be repeated. The constitution must be sustained, and the cicatrix supported by a bandage; otherwise it may ulcerate, especially if it is blue, soft, spongy, and elevated.

INDOLENT ULCER.

This is the most common of all ulcers, and occurs most frequently in the lower extremity and in old persons. It is owing frequently to a healthy sore having been neglected or badly treated. Its surface is

smooth, glassy, concave, and pale. The discharge is thin and serous. Its margin is elevated, round, white, and callous, resembling a cartilaginous ring surrounding a mucous membrane. The surrounding integument is swollen, hard, and of a dusky red colour.

It has little sensibility, and the patient is apt to let it go unnoticed, unless by accident, exposure, or over-exertion, it inflames and becomes painful.

Treatment.—At first a poultice will be serviceable by cleansing the sore and diminishing the inflammation and pain which usually precede the application for relief, which a purge and rest will assist in producing. The surface should be lightly touched with nitrate of silver or nitric acid, in order that healthy granulations should sprout; or, pressure may be employed to produce the same effect by means of strips of adhesive plaster and bandages. Small doses of opium are also useful in maintaining the capillary circulation.

IRRITABLE ULCER.

This has been defined as possessing an excess of organizing action with a deficiency of organizable material. It is superficial, having an equal surface of a dark hue, and often covered with tenacious fibrin. It occurs most frequently near the ankle. The edges are thin, serrated, and everted. The discharge is thin, acrid, and bloody. It is very sensitive, attended with great pain, and produces often peevishness of disposition.

Treatment.—Rest, elevation, and relaxation of the part. Nitrate of silver produces a sedative and antiphlogistic effect. This should be followed by a light poultice, or warm-water dressing, or if there is great pain, fomentations of the infusion of opium, conium, or belladonna.

PHAGEDENIC ULCER.

This is of an irregular form, with ragged, abrupt edges, and uneven brown surface, looking as if gnawed by the teeth of an animal. It is attended with burning pain, and great constitutional disturbance.

It frequently assumes a sloughing form, as in hospital gangrene, and cancrum oris, when the discharge is extremely fœtid.

Treatment.—Should be both constitutional and local. Fresh air and good diet are all-important; the secretions must be corrected and a Dover's powder given at night. Locally, there should be applied active escharotics, such as nitric acid, nitrate of mercury, &c., followed by warm poultices; these may be superseded by warm solutions either of the chloride of lime or of tincture of soda. Mercury must never be given, especially in cases of a venereal taint.

VARICOSE ULCER.

This is dependent upon a varicose condition of the veins, and usually occurs in the leg, just above the ankle. They are oval and superficial,

and attended with deep-seated, aching pain. They are indolent, and usually moist upon the surface.

Treatment.—The cure must depend upon removing the disease of the veins. Great relief will be found in the constant use of cold water, rest, regular bandaging, or laced stockings.

Certain ulcers are not to be healed, for example, when an ulcer has been stationary for years, when the patient is old, gouty, or a high liver; it may be looked upon as a safety valve, and any tendency to unite as indicative of impaired health. The sudden cessation of a drain of pus might be followed by hemorrhage, apoplexy, or inflammation of some important organ.

ERYSIPELAS.

Erysipelas is an inflammation of the skin and subcutaneous cellular tissue, having a tendency to spread.

The *cutaneous* form is characterized by redness, elevation, and burning pain; compression produces pale dimples, which soon disappear, and the cuticle vesicates. It usually terminates in a week or two, but may return to some other part.

The *phlegmonous* or *cellulo-cutaneous* form is more severe. The swelling is greater, the colour darker, and the pain more severe. Thin, ichorous pus is formed, which infiltrates the cellular tissue, and thus ulcerations and sloughs follow. The constitution sympathizes; at first the fever is high, then there are signs of hectic, and at last prostration and collapse.

When it affects the head or throat, producing coma or dyspnœa, and when it occurs in feeble, old, or intemperate persons, there is great danger.

The *causes* may be fatigue, foul air, intemperance, epidemic influence, contagion, and injuries.

Treatment. — This must be adapted to the *age* and *constitution* of the patient; the young and plethoric will bear active antiphlogistic treatment constitutionally, whilst the old and broken down will need stimulants and tonics. In some instances, bleeding will be useful, followed by saline purgatives and diaphoretics. In highly inflammatory cases, an emetic administered early will also prove serviceable. But in most cases a tonic and even stimulating course of treatment will in the end be required.

The muriated tincture of iron and bark will be necessary in the latter stages, if there is debility; opium will allay the restlessness at night.

The *local measures* most useful are leeches, punctures, warm lotions, if the pulse is good; and mercurial ointment, or nitrate of silver applied to the surface. Extension of the disease may be prevented by strips of blistering plaster, encircling the part.

Deep incisions are to be made in case there is pus collected under the skin.

Chronic, or habitual erysipelas, is best treated by alteratives and aperients.

FURUNCULUS, OR BOIL.

Boils occur most frequently in the young, and in those of plethoric habit, and in those parts where the skin is the thickest. They are usually gregarious, and depend upon derangement of the primæ viæ, and frequently succeed eruptive diseases.

The swelling is of a conical shape, having a hard, red, and painful base, and a yellow apex. If left to itself it bursts and discharges pus, and a core or slough of cellular tissue. When completely emptied the heat and pain subside.

Treatment. — Poultices and warm fomentations should be applied early; as soon as pus has formed a free incision must be made; and the granulating wound dressed in the ordinary way.

ANTHRAX, OR CARBUNCLE.

This is a serious disease; it is a solitary inflammation of the cellular tissue and skin, presenting a flat spongy swelling of a livid hue, and attended with dull burning pain. It varies in size, and its progress is slow.

The constitutional symptoms are asthenic throughout, and the attendant fever is apt to become typhoid; prostration and delirium often terminate the case. It most frequently attacks high livers of an advanced age.

Treatment. — A free and early incision will evacuate sanious pus and fetid sloughs; this is to be followed by applications of caustic potash, in order that the dying parts may be thoroughly removed. Stimulating poultices and warm fomentations will clean the surface, and give rise to healthy granulations. Tonics and stimuli, such as bark, brandy, ammonia, are early required, particularly if the carbuncle is large, and system debilitated.

PERNIO, OR CHILBLAINS.

This is an affection of the skin, produced by sudden alternations of cold and heat, most commonly affecting the toes, heels, ears, or fingers. It is attended with itching, swelling, pain, and slight redness at first; it may afterwards become of a livid hue, with vesications and ulcerated fissures, which are difficult to heal.

Treatment. — There is a great variety of applications in domestic use for this disease, and some of them of the most opposite character. The most serviceable remedy under all circumstance, but particularly when there is ulceration, is the nitrate of silver. Temporary and soothing relief is produced by cold applications.

FROST BITE.

Severe exposure, combined with exhaustion and fatigue, irresistibly induces sleepiness, which, if yielded to, is followed by coma and death.

When a part of the body is frost-bitten it becomes contracted, pale, and insensible. It may take place without the consciousness of the patient; without care it terminates in gangrene.

Treatment.—Produce *moderate reaction*, which will restore circulation and sensibility, taking care that it be *not excessive*, which would lead to dangerous inflammation. First rub the part with snow, and then with cold water in a room without fire. For the comatose condition of the body produced by cold, also use friction with snow, in a cold room, afterwards substituting flax or flannel; gradually giving warm and stimulating drink, such as wine and water.

BURNS AND SCALDS.

There are three principal divisions of these injuries, which may be produced by hot fluids, vapour, flame, or solids.

1st. Those which produce mere redness and slight inflammation, terminating in resolution, and perhaps desquamation.

2d. Those causing vesications of the cuticle, which often dry up and heal; but if the cutis has been injured and inflamed, suppuration and ulceration will result.

3d. Those causing the death of the part, in which there is not much pain, and which are followed by sloughs.

Extensive burns, even if superficial, are very dangerous; and those upon the trunk are more fatal than those of the extremities. The symptoms are paleness and shivering, with a feeble, quick pulse; often prostration, coma, and death. The greatest danger is during the first four or five days, from collapse; subsequently from an affection of head, chest, or abdomen, or from prostration.

Treatment.—Bathing the part in cold water will mitigate the heat, pain, and inflammation; afterwards it must be protected from the air by cotton, or some bland unctuous substance, care being taken to discharge the vesicles without removing the cuticle. Calm the nervous excitement with opium, and prevent sinking, with wine and ammonia. Be careful of over stimulation, and promote the separation of sloughs by rest, poultices, and fomentations. Regulate the diet, and encourage granulations by water-dressings, medicated with salts of copper, zinc, or silver, or with chloride of lime. Contraction of cicatrices is to be prevented by mechanical means, and the function of joints is to be retained by passive motion.

WOUNDS.

Wounds are classified into incised, contused, lacerated, punctured, poisoned, and gunshot.

INCISED.

Treatment.—This consists in arresting hemorrhage, removing foreign bodies, bringing the edges together, and promoting adhesion.

Hemorrhage is arrested by cold applications, elevated position, and compression, or, if an artery has been cut, by a ligature, or by torsion.

Ligatures are usually made of silk or thread, and should be round or twisted, in order to divide the internal and middle coats of the artery. Animal ligatures are sometimes used on account of their speedy decomposition, and separation from the artery; ligatures of lead have also been used.

Compression can be effected by the tourniquet, bandages, and pledgets of lint; in lieu of a tourniquet a Spanish windlass may be used, which is made by tying a handkerchief around a limb, and twisting it tightly with a stick.

Styptics are also used where the vessels are small, and the *actual cautery* when the hemorrhage cannot be arrested by other means. Foreign bodies, such as pieces of glass, clots of blood, &c., &c., are to be removed from the wound, and the lips brought together by means of adhesive plaster applied to surfaces cleanly shaved, and free from moisture.

Sutures, or stitches, are to be used only when the edges cannot be approximated by other means. An *interrupted* suture is made by passing a needle, armed with a single ligature, through both lips of the wound, which are then to be drawn together without any great straining, and secured by a double knot. These stitches are to be made at intervals of about an inch, but should not be made in any tendinous structure, or highly inflamed part.

A *twisted* suture is made by transfixing the margins of the wound with a needle or pin, and passing around it a waxed ligature in the form of the figure 8, by which means the edges are brought in contact; the point of the pin, or needle, is to be protected with wax, and allowed to remain for several days.

The *continued*, or *glover's* suture, is nothing more than the ordinary mode of sewing cloth or leather.

CONTUSED AND LACERATED.

These resemble each other; are attended with little hemorrhage, because the arteries are torn, and do not bleed so much as when cut. They are dangerous, because they are liable to inflammation and sloughing, and are often complicated with foreign bodies; and they are more apt to produce constitutional disturbance and tetanus.

Treatment.—Adhesion is impossible; suppuration must take place, and the dead parts be thrown off; the reparation takes place by granulation. At first it will be necessary to arrest hemorrhage, remove foreign bodies, bring the parts in apposition by strips of adhesive plaster, and apply water-dressings, or a light poultice, according to the condition of the patient. Cold and other antiphlogistic means, such as bleeding and purging, must be used cautiously when there has been a great shock upon the system, otherwise the vitality of the parts will be depressed; and the risk of gangrene increased; but after fever

and suppuration are established, the usual means of combating inflammation may be employed. When the sloughs are numerous, and the discharge profuse, typhoid symptoms will appear, especially if the patient be much reduced by depletion and rigid diet.

PUNCTURED AND PENETRATING.

These are inflicted by sharp-pointed instruments, and are extremely dangerous, on account of the injury done to important parts, by opening vessels and cavities, and from the diffusion of purulent secretions, and the liability of tetanus.

Treatment.—After ascertaining that the wound contains no foreign matter, apposition is effected, and maintained by position, rest, and dressings, and the system placed under antiphlogistic regimen; adhesion is to be expected, or reparation by granulation. There may be severe secondary symptoms arising from secondary hemorrhage, or confined purulent secretions; it may be necessary to apply a ligature upon the artery above the ulcerated wound; or, to open and dilate it for the exit of pus or a foreign body before undiscovered.

POISONED.

These include bites and stings of animals, and the effect of dissecting wounds.

The stings of ordinary insects are not sufficiently severe to require surgical aid, unless in great number, and in peculiar situations. Children sometimes suffer with fever and headache, when stung in a number of places; and the suffocation produced by a sting in the pharynx is alarming.

Treatment.—For the common sting of a wasp or a bee, remove the sting of the animal with forceps, should it remain, and apply some stimulating application, such as turpentine, cologne water, or hartshorn. Hartshorn will probably give most relief, especially combined with cold applications. If there be faintness or depression, administer wine and opium. If the sting be in the fauces, use leeches internally and externally, stimulating gargles, and, if necessary, open the trachea.

Spiders, especially the tarantula, *scorpions*, and *serpents*, inflict a most severe injury. The bite of the *viper*, *cobra de capello*, and *rattlesnake*, is attended with great pain, swelling, constitutional disturbance, and death. In such wounds great caution must be used to extract the poison from the wound, and to prevent its passing into the circulation. Surrounding the limb with a ligature, bathing the wound with warm water, and sucking it, are all of use; but the application of cupping glasses, and scarification, is the most certain method.

The prostration of the system is to be treated with brandy and ammonia, and the pain to be relieved by opium. Various remedies are given internally, such as sweet oil and ammonia, but arsenic has a

most decided preference; the celebrated Tanjore pills each contain a grain; the proper dose is f ʒj to f ʒij of Fowler's solution.

Hydrophobia.—Hydrophobia is a disease brought on by inoculation with the saliva of a rabid animal, and characterised by intermitting spasms of the muscles of respiration, together with a peculiar irritability of the body and disturbance of the mind.

The first symptoms in the dog are shyness, want of appetite, drooping of his tail and ears, a suspicious, haggard look, red and watery eyes, constant snapping at and swallowing straws, and licking cold surfaces, such as stone and iron; afterwards respiration becomes difficult, viscid saliva flows rapidly, and there is inflammation of the fauces, and high fever. He is not always furious, nor does he always bite, unless irritated; his gait is staggering, and he dies in convulsions, usually after the fifth day.

The symptoms in man vary with constitution and habit, and usually appear between five and ten weeks subsequent to the bite.

The wound heals as usual; after a time there is pain and itching in the cicatrix, which gradually increases, and ulceration follows. There is headache, restlessness, fever, and excitement of the nervous system. The mind is particularly clear and active; the memory strong, the imagination vivid, the countenance animated, and the eyes sparkling. This is succeeded by despondency, and the dread of fluids, great agitation, spasms, difficulty of breathing. Every attempt to relieve the burning thirst is followed by convulsive contractions of the neck and throat; sleepless despair, change of voice, croupy inspiration, and involuntary biting are the next symptoms. As the disease advances, the brain becomes more affected, and death is preceded by delirium.

Treatment.—The recent wounds should be treated by cupping-glasses and nitrate of silver. In not more than one case out of twenty does hydrophobia follow the bite of a rabid animal. The bite is much less dangerous when through the clothes. After the disease is established, nothing can be done with the prospect of cure; although every remedy and mode of treatment has been recommended. Palliatives and medicines which calm the nervous system and relieve pain may give some temporary relief.

Dissecting Wounds.—These are followed by unpleasant results more frequently in those of a scrofulous temperament, or in those whose systems are exhausted by study or dissipation.

The consequences may be a simple pustule, inflammation of the lymphatics, and typhoid fever, with diffuse abscesses.

The *pustule* has not much elevation, is surrounded by redness, and attended with burning and itching. When opened it discharges a little, thin pus, and is soon refilled, the excavation gradually increasing. This may not be followed by constitutional symptoms, unless the health is very bad.

The inflammation of the lymphatics is more apt to follow a small scratch or wound from examining recent subjects, especially those dy-

ing with peritonitis or any disease of serous membranes. The pain and swelling extend up the arm to the axilla, and there is fever and depression of spirits. The course of the inflammation can be traced along the lymphatics to the axillary glands, which often suppurate.

Extensive abscesses and typhoid fever take place when the poison is very violent and the system much prostrated.

Treatment.—The pustule will be managed best by a lye poultice, and then removing the coverings and touching the surface with lunar caustic. A simple incision or puncture for an ordinary pustule will not prevent the renewal of the matter.

When the lymphatics are inflamed, the original wound is not always the most tender spot, nor is there the appearance of a pustule. Leeches, cold applications, poultices of Indian meal and rye, nitrate of silver, and tincture of iodine are useful local applications. Bleeding may be necessary when the inflammation and fever are very high. Free incisions prevent the formation of abscesses, by evacuating the serum and depleting the part. Spreading abscess of the cellular tissue is attended with typhoid fever, and is very dangerous. The system must be supported by stimulants and tonics, such as brandy and bark; opium will allay pain and restlessness, and the local dressing will resemble that for abscess in general.

Fresh air, clean clothes, healthy skin, good diet, and regular habits will be found to be the best prophylactics.

GUNSHOT WOUNDS.

These include all injuries by fire-arms, and partake of the nature of lacerated and contused wounds. There is usually but little hemorrhage, unless a large vessel is injured. The nature and extent of the injury will vary with the distance, force, and character of the shot or slug producing it, and the part affected; fracture, contusions, and perforations may require amputation. The aperture made by the entrance of the bullet often appears smaller than the bullet, and resembles an incised wound with inverted edges; the aperture of its exit is larger, and has ragged and everted edges. The pain of a flesh wound is often so slight that it does not attract attention; but when a bone is broken or a nerve torn, the pain is severe. The shock upon the system is greater than in other wounds, and is partly corporeal and partly mental. Syncope and depression of spirits are very common attendants.

The idea of injury resulting from the *wind of a ball* is erroneous. Injuries may result from spent balls, which, having a rotary motion, may roll over the surface without producing an open wound.

The course of bullets is uncertain; any obstacle, such as a button, a watch, or a bone, may occasion a most devious track. A ball may strike the forehead, and emerge at the occiput, or, striking the sternum, lodge in the scrotum. A bullet may be divided into two parts by striking a sharp edge of bone; or it may bury itself, and remain concealed for years, being enclosed in a cyst.

When there is but one aperture, it is probable that the ball has lodged; though it may have escaped upon the removal of the clothing, if a portion of the clothing should have been carried before it into the wound; or, the ball may make a complete circuit, and escape by the aperture of entrance; in this instance the track would be discovered by redness and swelling. When two orifices are in a straight line, it is not always to be inferred that the ball has escaped, for two balls may have entered opposite each other; the character of the orifices will determine this point. A plurality of openings does not always imply a plurality of balls; the same bullet may perforate and escape, and perforate again.

The wound partially sloughs and may produce abscess, erysipelas, hemorrhage, disease of the bones, hectic, or tetanus.

Treatment.—The general indications are to overcome the shock, remove foreign matters, adjust the parts, and place them in a comfortable and relaxed position.

A simple wound, made by a ball passing through some fleshy part, should at first be sponged clean, and after hemorrhage has ceased, dressed with dry lint, secured by strips of plaster. A little wine and laudanum may be given if the patient is disposed to faint, or suffers much with anxiety and fear. In a few days there is inflammation and suppuration. The primary dressings are to be removed with warm water, and a poultice or the water dressing substituted. Care must be taken that the sloughs are readily thrown off, and that no sinuses are formed. The constitutional treatment should be moderately antiphlogistic; consisting of purging, low diet, leeches, and perhaps bleeding; an opiate at bedtime will allay pain and twitching.

The presence of bullets and other foreign bodies can be detected by a probe, and they are to be removed by a forceps, the wound having been dilated, if necessary. If they are superficially lodged, they are to be cut down upon, extracted by a counter opening; if they are deep-seated and impacted, wait for the suppurative stage. When lodged in bone, they may be removed by a chisel or trephine, lest they produce caries or necrosis, although in many instances they have become encased and occasioned no inconvenience.

The question of amputation will be settled by considering the liability of gangrene, the usefulness of the limb if retained, the age, habits, and strength of the patient, and the means at hand for carrying out the treatment. The latter consideration will justify more numerous amputations in military and naval than in civil surgery. The following circumstances make amputation necessary.

When a limb is completely knocked off by a cannon-ball. If the bone is shattered and the joint endangered, it should be amputated above the joint.

When the femur is fractured, and the femoral artery or vein, or the sciatic nerve is lacerated.

When large joints are injured; but that of the elbow may often be excised.

When the main artery is wounded, and gangrene has commenced and is spreading.

TETANUS.

Is a disease of the true spinal system, and is manifested by spasm and rigidity of voluntary muscles.

When the muscles of the neck and face are affected, it is termed *Trismus*, or locked jaw; when the muscles of the front, *Emprosthotonos;* when the muscles of the back, *Opesthotonos;* bending to either side is termed *Pleurothotonos.*

Tetanus may be either an *acute* or *chronic* disease; the former is the most frequent in occurrence, and most formidable to treat; the latter, apt to be partial, milder, and more subject to treatment.

Traumatic tetanus follows a wound or injury, and is usually acute; *idiopathic* tetanus is of spontaneous origin, and usually chronic.

Acute traumatic tetanus is more frequent in hot climates, and in military practice, and may follow a slight bruise or puncture, especially if some nerve has been injured. Intestinal irritation and atmospheric changes predispose to the disease.

The symptoms may appear in a few hours, or in as many days; at first there is stiffness and soreness about the neck and face, the contraction of the muscles causing a ghastly smile; swallowing and mastication are difficult, the forehead is wrinkled, eyeballs are distorted, nostrils dilated, and the grinning countenance is expressive of horror. Respiration is rapid, the tongue protrudes, and saliva dribbles; the sphincters are usually contracted, perspiration is profuse and of a peculiar odour; the pulse at first may be strong and full, but soon becomes weak and indistinct. The mind is clear until just before death, which generally takes place in a few days.

Treatment.—The indications are to remove all sources of irritation, and diminish the spasm. The wound is to be cleansed from all foreign bodies, pus to be discharged by a free incision, if necessary, and warm anodyne poultices and fomentations are to be applied. Excision of the wound, or division of the nerve leading to it, has been practised with great benefit. Bleeding should be employed with great care, and purgatives combined with mercury are always of advantage. Nutrition and opium are almost indispensable, and may be used externally and internally. Camphor, musk, assafœtida, and tobacco are also of use as antispasmodics; cannabis indica and ice to spine, have been used advantageously in some few cases.

Chronic tetanus is seldom fatal, and frequently idiopathic; it lasts several weeks, and should be treated by the shower-bath, tonics, and electricity. Ether or chloroform may be used with advantage.

DISEASES OF BONES.

CARIES.

Caries is an unhealthy inflammation of the bone, attended with softening, and leading to suppuration and ulceration. The bone has its cells filled with serous, and often with scrofulous fluids, and when dried has a spongy and worm-eaten appearance, and resembles a lump of sugar after being dipped in hot water. The disease most frequently attacks the thick bones, and the extremities of long bones; and it may result from local injury, or simply from constitutional causes, such as scrofula, or effects of mercury. It is attended with pain and swelling, and after ulceration there is a fœtid discharge containing portions of bone.

Treatment.—The constitutional treatment consists of fresh air, tonics, and alteratives; and the local treatment in removing those portions incapable of repair, and endeavouring to establish healthy granulations. Sometimes it may be necessary to remove loose portions of bone which are disintegrated, and to apply escharotics to the surface.

CARIES OF THE SPINE.

This occurs most frequently in children, and in persons of a scrofulous temperament. At first there is a sensation of numbness in the lower extremities, languor, and a stumbling gait. The patient usually sits with his legs drawn up under the chair, has a constriction of the chest, and derangement of the digestive organs; in a short time paralysis ensues, and there may be a pointing of matter at some portion of the spinal column, most frequently about the dorsal vertebræ. The bodies of the vertebræ are softened and compressed, and thus a curvature takes place; the convexity of which is most frequently directed posteriorly. Many die from fever and irritation, and recovery is usually attended with deformity.

Treatment.—Absolute rest upon a mattrass, attention to the general health, counter-irritations over the tender point, by means of blisters and issues, and in the early stages, leeching. The diet should be light and nutritious, and a laxative administered occasionally.

NECROSIS.

This signifies the death of the bone, which is often enclosed in a case of new bone. When a superficial layer is affected it exfoliates; the dead portions thrown off are termed *sequestra*. It occurs at all ages, and most frequently in the compact bones; the immediate cause is inflammation of the periosteum. It is attended with swelling, and a discharge of matter through openings in the case of new bone, which are termed *cloacæ*. The pain is deep-seated, long-continued, and very severe.

Treatment.—This is principally local, although constitutional remedies may be given to allay pain. The great object is to facilitate the escape of pus and the sequestra; it is often necessary to enlarge the cloacæ by a saw or trephine, and to dilate the sinuses with lint. Amputation may be necessary in case the joints are involved.

EXOSTOSIS.

This is a tumour formed by an excessive and irregular growth of bone. The shape varies, being sometimes broad, and sometimes spiculated. The structure is healthy, and it may cause no inconvenience, unless it interferes with an artery, muscle, or joint.

Treatment.—The object is to produce absorption, by means of mercury, iodine, blisters and leeches; but since these usually fail, it is necessary to resort to an operation This may be performed by a saw or trephine. Scraping off the periosteum is also recommended.

FRAGILITAS OSSIUM.

This is a brittleness of bones, occurring frequently in youth, but oftener in old age. The proportion of earthy matter is relatively but not actually increased. The cancellated structure is filled by an oily substance, and surrounded by a thin, brittle lamella. This degeneration follows long confinement, intemperate habits, and rheumatic and cancerous affections. A hasty step, turning in bed, or tripping on a carpet, may produce fracture.

Treatment.—In old persons all that can be done is to guard against any accident, and to enjoin a nutritious diet and salubrious atmosphere. In children, care should be taken to overcome a scrofulous constitution by tonics and good diet, and to treat the fracture as usual.

MOLLITIES OSSIUM.

This is a deficiency of the earthy matter of bones, and hence they are soft and pliable. This disease occurs in adults, and its course is rapid; the general health is impaired; flesh, spirits, and strength, diminish daily. The bones are light, soft and greasy, and often consist of an external shell, filled with a soft, greasy matter. The cause is obscure; phosphatic deposits are found in the secretions.

Treatment.—This is merely palliative, for the disease is incurable.

RICKETS.

This is an original defect of the skeleton, peculiar to youth and scrofulous temperaments. The bone is changed in its structure, becoming soft and pliable, as in mollities ossium. The cancellated structure predominates, the cells being filled with a reddish oily fluid. The flat bones are often thickened, and the long bones atrophied in

the shaft. This disease gradually increases with age, and hence great deformity, and curvatures of limbs must necessarily occur. In adult life, the general health may be regained, and the patient, though a confirmed and unseemly dwarf, weak and puny in his boyhood, may prove a healthy, muscular, and active man.

Treatment.—Improvement of the general system by diet, exercise, proper clothing, and tonics. Mechanical apparatus, properly constructed, may be of service in preventing permanent deformity. Those articles of diet which are readily converted into lactic acid, such as sugar, starch, gum, milk, &c., should be avoided, and animal food of easy digestion preferred.

SPINA VENTOSA.

This is a swelling, usually of considerable extent, involving the whole circumference of the bone, and has a regular surface. In most instances, it is a bony shell, containing one or several cavities, filled with an ichorous fluid, clotted blood, and portions of carious bone. It is preceded by severe pain, and external injuries and constitutional causes may give rise to it. It is difficult to cure, especially in adults.

Treatment.—When the tumour is small, the cure is to be effected by means of puncture, satisfactory evacuation, external support, and internal stimulation of the cavity. If the tumour is large and the general health affected, amputation will be necessary.

OSTEO-SARCOMA.

This is a tumour, composed partly of bone and partly of flesh, and is usually considered of a malignant nature. A *dissection* of the tumour presents a dense, pearl-coloured membrane, covering the surface, and adhering closely to the bone; above this membrane the muscles are thin and spread out, so as to cover an extensive surface, having lost their colour. Upon opening the tumour, it will be found to contain cells divided by spiculæ of bone, and materials resembling flesh, jelly, and fat. It is attended with deep-seated pain, and at last bursts, assuming a cancer-like ulceration.

Treatment.—At first, leeches, cold applications, and anodynes, may give temporary relief, but no permanent benefit can be expected without its removal; and even after amputation, it frequently attacks the stump.

COXALGIA (FIG. 215).

This is a disease of the hip-joint, common to scrofulous children.

Symptoms.—At first there is slight pain, referred to the knee; lameness, and stumbling in walking; tenderness in the groin, and pain is produced by pressing the head of the bone suddenly against the

Fig. 215.

acetabulum; apparent lengthening of the limb. This apparent increase of length is owing to a depression of the pelvis of the diseased side, the weight of the body being supported on the opposite limb.

If the disease is not arrested, destruction of the head of the bone and acetabulum results, and the femur is drawn up, constituting a spontaneous luxation. Often an abscess forms, and opens externally. The toes may be turned inward or outward.

Treatment.—Perfect rest upon a mattrass, as in caries of the spine, the limb being confined in a carved splint. Cups and leeches, over the joint, will be useful at first; subsequently, more benefit will be derived from counter-irritation by blisters, setons, and issues. Purging with jalap and cream of tartar, tonics, and iodine, are the constitutional remedies. It may require months or years to effect a cure.

FRACTURES.

Fracture is a solution of continuity of a bone, produced by external violence, or muscular contraction. Fractures are divided into oblique, transverse, and longitudinal, according to the direction. *Simple* fracture is a mere separation of the bone into two parts; *compound*, implies an open wound, communicating with the fracture; *comminuted*, when the bone is broken into numerous fragments; and *complicated*, when attended with luxation, laceration of large vessels, &c.

The *signs* of fractures are deformity, preternatural mobility, crepitation, pain, swelling, and helplessness of the part. Old age, and certain diseases of the bone, predispose to fractures; in cold weather, they are more numerous, on account of the increased muscular exertion necessary in walking, where there is ice. Indirect violence may occasion fracture, when a force is applied to the two extremities of the bone, which gives way between them. Deformity may be produced by an angular derangement, or a derangement in the direction of the axis, the diameter, or the circumference of the bone. Bent bones are occasioned by a few of the osseous fibres giving way upon the convexity of the curve. The process of reparation is more rapid in the young, and also takes place sooner in a small than in a large bone. Danger results, according to the site of the injury, the nature of the fracture, and the state of the system. The mode of reparation is attended by the following changes: extravasation of blood; after this is absorbed, the liquor sanguinis is effused, and assumes the position

which the blood occupied; this consolidates; the serous portion is absorbed; the fibrin remains, and becomes organized. This period of plastic exudation lasts for eight or ten days, and then becomes cartilaginous. This mass contracts, increases in density, and gradually becomes bone. The ossification advances from the periphery. The fractured extremities are now surrounded by a bony case, termed the *provisional callus;* after which continuity is truly restored by the formation of what is called *definitive callus,* which takes place between the fractured extremities; and, finally, the provisional callus is absorbed.

Treatment. — This consists of two parts; first, *reduction,* which is to be effected gradually by extension and counter-extension, overcoming muscular contraction, and coaptating the extremities; secondly, *retention,* which is effected by keeping the limb in such a posture as will relax those muscles which would be likely to cause a displacement, and by applying such mechanical means as will prevent motion; these means consist of splints, which are variously constructed of wood, pasteboard, or metal, and applied by means of bandages or rollers; they should be light, and always of such a length as to command the neighbouring joint; the inner surface should be padded or lined, in order to prevent chafing. After being dressed, the part should be laid upon a pillow, and not disturbed, unless there should be inordinate swelling of the limb, when the bandage should be loosened. Bandages soaked in gum or starch, have recently been used, in place of splints. Under certain circumstances, this dressing is admirable, but an indiscriminate employment tends manifestly to injury; on account of the swelling of the limb, it produces pressure, which may occasion ulceration or sloughing. It is called the immovable apparatus.

The diet should be watched, and antiphlogistic means resorted to, if necessary. At the end of three to six weeks, the provisional callus is complete, and the substitutes for this splint of nature can be discontinued; the use of the part must be resumed gradually, especially in the lower limbs.

FRACTURE OF THE NOSE.

The nasal bones are usually fractured by a fall, a violent blow, or kick of a horse, or some direct application of force. This fracture is often attended by injury of the brain, and followed by caries and exfoliation.

Treatment.—This consists of antiphlogistic means, such as leeches, cold applications, and rigid diet, to remove swelling and inflammation, and the adjustment of the fragments; which can be accomplished by a catheter, probe, or dressing forceps. The nose should not be plugged with lint, unless to check profuse hemorrhage. The parts may be retained in apposition by compresses and rollers.

FRACTURE OF THE MALAR AND SUPERIOR MAXILLARY BONES.

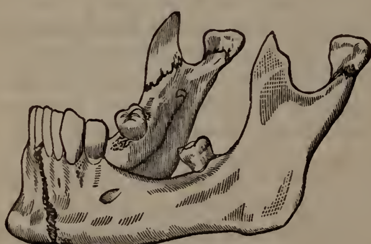
These can only occur by the most direct violence, or gunshot injuries, and are usually attended with crushing and wounding of the soft parts; severe inflammation and nervous symptoms may come on, and the brain may also be affected. There will be great pain and difficulty in chewing. Fragments of the malar bone frequently become necrosed.

Treatment.—If there is no displacement, there is nothing to be done but to subdue inflammation, and keep the parts quiet. If the alveolar processes are loosened, they must be pressed into their places, and there retained by fine wire secured around the teeth. The mouth is to be kept shut, and the patient nourished by fluids.

FRACTURE OF THE LOWER JAW (FIG. 216).

This may occur in the base of the jaw, in the ramus or processes; and in children it may take place at the symphysis. The most frequent seat of fracture is between the chin and the insertion of the masseter muscle; the longer fragment and the chin are depressed. In double fractures, the chin alone is depressed. There is pain, swelling, inability to move the jaw, irregularity of the dental arch, crepitus, and frequently hemorrhage and deafness.

Fig. 216.



The diagnosis of fracture of the ramus and condyle is often obscured by swelling; the neck of the condyle is drawn forwards by the external pterygoid muscle, and crepitation will be perceived by the patient.

Treatment.—The teeth serve as a guide in the adjustment of the fragments, and the upper jaw acts as a splint in the retention. A compress and a pasteboard splint, retained by a suitable bandage, will retain the parts in apposition; and the patient is to be fed by gruels and soups, through the interstices of the teeth. Fragments of the lower jaw can often be held in apposition by passing fine wire or saddlers' silk around the teeth. The union is rapid, and there is usually but little deformity.

FRACTURE OF THE SPINE.

This is attended with serious injury to the spinal cord, from com-

pression, laceration, bruising, concussion, or from subsequent inflammation and softening. When it occurs above the fourth cervical vertebra, death is almost certain, on account of the origin of the phrenic nerve which supplies the diaphragm.

When the lumbar region has suffered, the symptoms are paralysis of the lower limbs, involuntary discharge of fæces, retention of urine, and frequently priapism.

When the injury is in the upper dorsal or lower cervical region, there is, in addition to these symptoms, paralysis of the arms, difficulty of breathing, sluggishness of the bowels, and distension of the abdomen. In all fractures of the spine, the bladder becomes distended, the urine dribbles, and bedsores are apt to follow.

Treatment.—Absolute rest upon a mattrass, low diet, and antiphlogistic means, to prevent the formation of pus, and thickening of the membranes. The discharges of the bowels must be regulated, and the bladder relieved by the catheter; counter-irritation and frictions will be useful in the latter stages of the case. The use of the trephine in this injury has not met with success, and will probably do more harm than good.

FRACTURE OF THE PELVIS.

Fracture of the bones of the pelvis can only be produced by the greatest violence. There is but little displacement, although great danger results from injury to the parts within.

Treatment.—All that can be done is to place the patient at rest in an easy position, keep a catheter in the bladder, and make incisions, if urine or pus is extravasated in the perineum. The application of a broad bandage around the hips, will assist in preventing motion.

When the crest of the ilium or the anterior superior spinous process is knocked off, the fragment is displaced inwards, and can be readjusted by the fingers. Fracture of the sacrum is longitudinal usually, and there is no displacement. The coccyx may be fractured by a kick, and is displaced inwardly: re-adjustment may be effected by the finger in the rectum. The acetabulum may be split, and injury of the neck of the femur may be simulated, though there is no shortening of the limb, and crepitus is felt by the finger in the rectum, when the pelvis is moved.

FRACTURE OF THE RIBS (FIGS. 217, 218).

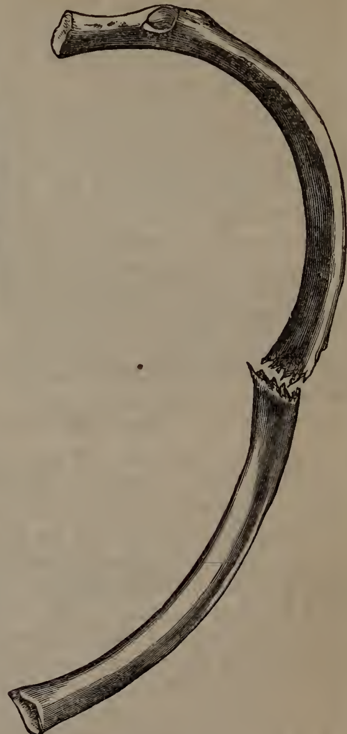
The ribs are very liable to fracture, which usually is in the middle, when occurring from direct force, or force applied at each end. Displacement is seldom great, and is difficult to detect in fat persons. There is pain, swelling, and difficulty in breathing; crepitus is felt, when the hand is placed over the part during respiration or coughing; emphysema appears when the pleura is injured.

Treatment.—If there is an angular projection of the extremities, a compress is to be applied over it; if there is a depression, a compress is to be placed at each extremity. Strips of adhesive plaster, 1¼

inches in breadth, are to be applied from the spine to the sternum, in order to prevent respiration by the intercostal muscles, and thus to

Fig. 217.

Fig. 218.



keep the parts at rest. Inflammation and cough are likely to ensue, and must be treated by antiphlogistic means and anodynes.

Compound fracture of the ribs is treated of, under the head of Wounds of the Chest.

FRACTURE OF THE STERNUM.

Fracture of this bone is rare, great violence being necessary to produce it; injury usually is done to the thoracic viscera. The deformity is generally a depression, and the symptoms are great difficulty of respiration, pain, palpitation of the heart, and perhaps spitting of blood, and cough. Caries, or a pulmonary affection, often result from a fracture of the sternum or ribs in scrofulous habits.

Treatment.—The local treatment consists of adhesive strips applied upon the same principles as in fracture of the rib. The general

treatment must be adapted to the inflammatory conditions of the organs of the chest. Collections of pus and blood behind the sternum can be evacuated with a trephine, but the operation is often attended with unfavourable results.

FRACTURE OF THE SCAPULA.

The *acromion* process is sometimes fractured; the shoulder loses somewhat of its roundness, the head of the humerus falls slightly, and there is a slight depression at the point of fracture. It is distinguished from dislocation by mobility of the joint, and crepitation can be felt by rotating the head of the humerus.

Treatment.—It may unite by bone, but generally it unites by ligament. It is to be kept in its place, by elevating and firmly fixing the os humeri; this is effected by placing a cushion between the side and the elbow, and retaining it by a roller, the elbow being carried a little backwards. If the pad be placed in the axilla, and the elbow be brought close to the side, the fragments will be separated; but little inflammation follows, and bandages may be removed in three weeks. In many individuals, the tip of the acromion process is slightly movable, being merely united by ligament.

The *neck of the scapula* is rarely fractured, and it is liable to be mistaken for a dislocation; the shoulder falls; there is a hollow below the acromion, from a sinking of the deltoid muscle; and the head of the humerus can be felt in the axilla. It can be recognised by the facility with which the parts are replaced, the falling of the head of the bone into the axilla, when the extension is removed, and by crepitation.

Treatment.—The first point is to carry the head of the humerus outwards, and the second to raise the glenoid cavity and arm. The former is effected by a thick cushion confined in the axilla by a bandage, and the latter by placing the arm in a short sling. Ten or twelve weeks are necessary to procure union, and a still longer time to recover the strength of the arm.

The *coracoid* may be fractured by direct violence; the process is drawn downwards, by the action of the coraco-brachialis, pectoralis minor, and biceps muscles. There is pain, swelling, and crepitation in the part, and loss of power in the limb.

Treatment.—This consists in making the fingers of the injured limb touch the shoulder of the opposite side, the position being secured by bandaging. The union is usually ligamentous.

The *body* of the scapula may be fractured either vertically or transversely, and there is but little displacement, unless it is near the lower angle of the scapula. When the angle is fractured, it may be drawn forward and upward.

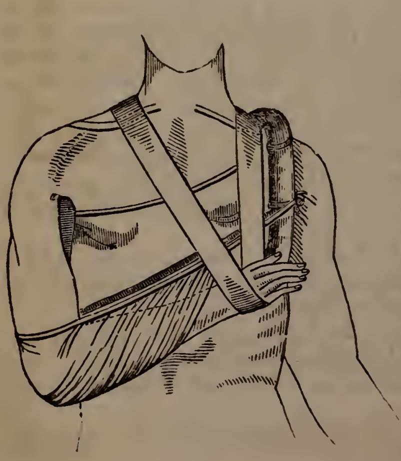
Treatment.—This consists of a tight roller around the chest; the arm being placed in a sling.

FRACTURE OF THE CLAVICLE (FIG. 219).

This fracture is frequent, and is usually produced by violence upon the shoulder, arm, and hand. It is generally oblique and near the middle of the bone; the part is painful and swollen, and every attempt at motion produces pain; the shoulder is sunken, and drawn towards the sternum, and the acromial fragment is drawn downward by the weight of the arm, and forward and inward by the action of the subclavius muscle. The patient usually supports the arm with his other hand, to relieve the pressure upon the axillary plexus of nerves. The indications are plain, viz.: to elevate the shoulder; to keep it outward from the chest; and to draw it slightly backward.

Treatment.—The mode of dressing this fracture is extremely various. *Desault's apparatus* consists of a compress placed over the fracture, a wedge-shaped pad placed in the axilla, and retained by a roller which surrounds the chest. The elbow is to be brought to the side, and the arm and chest surrounded by circular turns of a second roller, whereby the shoulder is elevated and drawn outwards. A third and last roller commences at the armpit of the sound side, and being carried obliquely over the compress, descends the posterior portion of the arm, passes under the elbow, and obliquely upwards across the chest to the armpit, whence it started; then over the back to the shoulder of the affected side, across the compress, down in front of the arm, under the elbow, and across the back to the sound armpit again. This bandage serves to retain the arm and shoulder in its elevated position.

Fig. 219.



Fox's apparatus (Fig. 219) consists of a wedge-shaped pad, secured by strings to a circular collar which surrounds the shoulder of the sound side, and a sling made of linen, which contains the forearm; it elevates the shoulder, and by bringing the elbow to the side, draws the shoulder outwards.

Some use merely a pad and two handkerchiefs, which, if properly applied, can be made to fulfil all the indications in ordinary cases.

FRACTURE OF THE HUMERUS. (FIG. 220.)

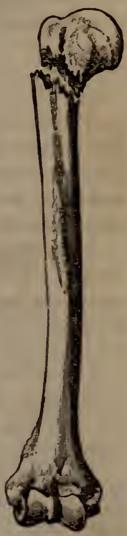
The *anatomical neck* is the seat of fracture in young persons, and sometimes in old. There is little or no flatten-

ing of the shoulder, owing to the head of the bone remaining in its place; the end of the shaft is directed obliquely upwards and forwards, and projects on the coracoid process; the arm is shortened, and crepitus is distinct after slight extension and coaptation of the fragments.

Treatment.—This requires a pad in the axilla, a splint on the fore and back part of the arm, a roller, and a sling for the hand, the elbow hanging free.

The Surgical Neck (Fig. 220).—The upper fragment remains in place, but its lower extremity inclines slightly outwards; the upper end of the lower fragment is drawn upwards and inwards under the pectoral muscle; the shoulder is round, the arm shortened, the elbow abducted, and there is crepitation upon adjustment.

Fig. 220.



Treatment.—A pad is placed in the axilla; the two splints secured by a roller; the hand supported by a sling, and the elbow free.

Fracture at the Neck may be accompanied with *dislocation*. This is recognised by the tumour in the axilla, formed by the head of the bone, which does not move when the shaft is rotated.

Treatment.—An effort should be made to restore the head of the bone, and then to coaptate the extremities; this is often impossible; then the extremity of the lower fragment should be brought to play in the glenoid cavity. A pad will be necessary in the axilla, and the same dressing as the last. A new joint is formed, and the motions of the arm are only partial.

The *shaft* may be fractured at any point, and is easily recognised by crepitation; and when the fracture is just below the surgical neck, the lower extremity of the upper fragment is drawn inwards by the muscles inserted into the bicipital ridges, and the upper extremity of the lower fragment is drawn outwards by the deltoid muscle.

Treatment.—The reduction is easy, and the extremities may be retained in contact by four small splints placed around the arm, and secured by a roller, which, as in all other instances of its use in the upper extremity, must commence at the hand. The forearm should be suspended in a sling.

The *condyles* are fractured in various ways. Either condyle may be fractured, most frequently the internal; or, there may be a fracture between the two condyles, and another separating them from the shaft. These injuries are distinguished from dislocation at the elbow by mobility and crepitation.

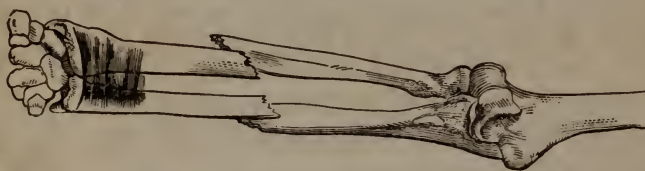
Treatment.—By a roller and two angular splints (Physick's), reaching to the hand from the middle of the arm. The angle of the splints

must be changed to prevent anchylosis. Some deformity and stiffness often remain.

FRACTURE OF THE RADIUS AND ULNA (FIG. 221).

When both bones of the forearm are fractured at once, or when either bone is fractured near the middle, there is but little difficulty in the diagnosis. The injury is recognised by the ordinary signs of fractures, such as pain, crepitus, swelling, and uselessness of the limb.

Fig. 221.



Treatment.—The great object is to preserve the interosseous space; for, if the fragments unite at an angle, supination and pronation will be prevented. The fracture is readily reduced by slight extension, and then the muscles should be pressed into the interosseous space, in order to separate the two bones.

Two splints, well padded on the inside, reaching from the elbow beyond the fingers, should be applied, and retained by a roller. The arm must be kept in a position between supination and pronation, and supported by a sling; after three weeks pasteboard splints or a starch bandage may be substituted.

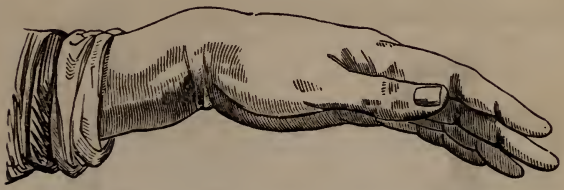
The RADIUS is more frequently fractured than the ulna, on account of its articulating with the carpus, and thus receiving the weight of the body in falls, &c. When fractured near the middle there is but little deformity, the ulna acting as a splint.

The *neck* of the radius is but rarely fractured, and the accident is difficult to recognise, especially when the muscles covering it are very large. It is to be discovered by fixing the head of the bone, and rotating the hand and forearm.

The *lower extremity* of the radius is often fractured, and frequently mistaken for a dislocation of the wrist. The most frequent seat of fracture is about half an inch above the joint. Barton's fracture involves the articular surface, and Colles' fracture is an inch and a half above. (Fig. 222.)

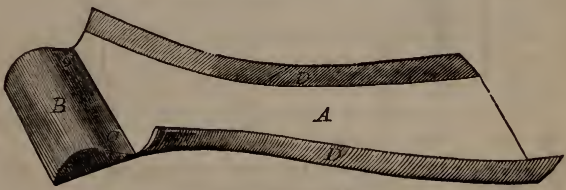
Fractures of the radius are to be treated upon the same principles, and by the same means as in other fractures of the forearm, unless the fracture should be near the articular surface of the carpal extremity of the radius. This latter fracture gives a peculiar deformity to the wrist, dependent upon a partial luxation of the carpus. In this instance, two small compresses are to be applied, one upon a pro-

Fig. 222.



minence on the dorsal surface caused by the fragment, the other upon the projecting extremity of the radius on the palmar side. Of course these compresses will not be opposite to each other. The wrist should be placed in a Bond's splint. (Fig. 223.)

Fig. 223.



The ULNA is most frequently fractured below the middle of the shaft. The lower fragment approximates the radius by the action of the pronator quadratus, and the other usual symptoms of fracture are evident.

The *olecranon* process is often fractured by sudden violence, or muscular action. The fragment is drawn up upon the back of the arm by the triceps muscle, and the deformity is increased by flexion. The union is usually ligamentous. (Fig. 224.)

The *coronoid* process is rarely fractured, and usually by inordinate muscular action of the brachialis anticus muscle, whose tendon is inserted in front of the base of this process. Dislocation backwards by the action of the triceps may result. The union will be ligamentous. (Fig. 225.)

Treatment.—Fractures of the shaft are to be treated by two splints and compresses, as are those of the radius. Fracture of the olecranon is to be treated by extending the elbow, placing a small splint in front of the joint, and securing it by a roller. The coronoid is to be treated by flexing the elbow, the fingers touching the opposite shoulder, applying a roller to relax the muscles and prevent their action, and keeping the forearm in a sling.

Fig. 224.

Fig. 225.

FRACTURE OF THE CARPUS, METACARPUS, AND PHALANGES.

The bones of the carpus are seldom fractured. The injury is usually a compound one, and produced by direct force.

The metacarpal bones are subject to simple fracture, which is easily recognised by pain, swelling, crepitus, &c. The treatment consists of coaptation of the fragments, and retaining them by means of two splints and interosseous pads, or compresses.

The *phalanges* are liable to compound and simple fracture. Simple fractures to be treated by two or four small splints, and a narrow bandage; when several fingers are broken, a carved splint will be useful.

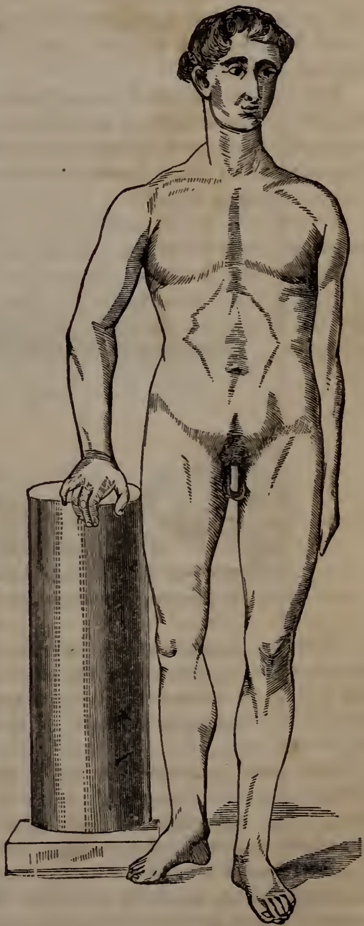
FRACTURE OF THE FEMUR (FIG. 226).

The *neck* may be fractured within the capsule. This occurs most frequently in old persons, and in females, on account of the bony texture being more brittle in advanced life, and on account of the anatomical character of the neck of the femur in women. The accident may be produced by a slight fall, muscular contraction, blows, &c. The head of the bone remains in the acetabulum; the lower fragment is drawn upwards by the muscles of the hip, and the foot is everted, owing to the action of the rotator muscles. The limb is shortened, the trochanter is one or two inches higher and flatter than its fellow; there is pain, crepitus, and want of voluntary motion. The arc which

the trochanter, upon rotation, will describe, will be of a much smaller circle than that described by the rotation of its fellow.

Union is possible, but improbable; on account of the difficulty of coaptating the fragments, the want of provisional callus, the fractured extremities being bathed in an increased quantity of synovia, and the feeble nutrition of the head of the bone through the round ligament. Yet, in a young person of good constitution, where the periosteum is not completely severed, there may be bony union. Ordinarily, there results a false joint, thickening of the capsule, partial absorption of the fragments, and the patient is lame for life, and requires a stick or crutch. Feeble old women may die from the shock of the injury, or from the irritation of pain and confinement.

Fig. 226.



Treatment. — Extension and splints are unnecessary in old persons, the limb should be supported by pillows, and motion restrained. Care should be taken with reference to bed-sores, sloughs, &c.

The *neck* may be fractured partly within and partly without the capsule, in which case the prospect of union is much more favourable. Or, the extremity of one fragment may be driven into the cancellated structure of the other, constituting an *impacted* fracture; in these cases, crepitus is obscure, the displacement is slight, and there is considerable power and motion of the limb, and but little shortening and eversion. They are produced by great direct force, and are attended with great pain, swelling, and constitutional disturbance. The treatment may be successful in many instances, without the use of splints.

The *trochanter major* may be fractured; the process is drawn upwards by the glutei muscles, and a space can be felt between the fragments. Approximation and retention are difficult, and the union generally ligamentous. The cure is to be effected by rest, position, and relaxing the muscles.

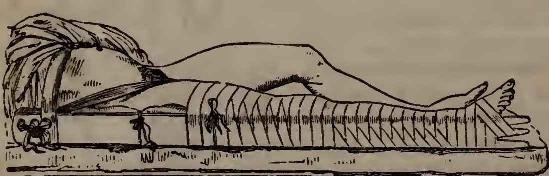
Fracture of the condyles is a serious injury, especially when communicating with the joint. After the fragments are somewhat consolidated by rest and position, passive motion must be established to prevent anchylosis.

Fracture of the *shaft* is easily recognized by shortening, crepitation, &c., &c. The deformity is greater when it occurs in the upper part, especially when just below the trochanters, the lower end of the upper fragment being tilted forward by the action of the psoas magnus and iliacus internus muscles.

Treatment.—The principles of treatment are, as in all fractures, coaptation and retention, but the means to effect it are various.

The double inclined plane is a simple contrivance. The leg is secured to one plane, which furnishes the means of counter-extension and the thigh rests on the other; the weight of the body produces the extension. *Liston's splint* is represented by Fig. 227.

Fig. 227.



Desault's Apparatus.—Consists of an outer splint, three or four inches wide, reaching from the crest of the ilium to four inches beyond the foot, each extremity having a hole in it; an inner splint reaching from the perineum to the sole of the foot, and an upper splint reaching to the knee.

The counter-extension is made by a band in the perineum, which is secured to the upper end of the outer splint by means of the hole in it. The extension is made by a band or handkerchief applied to the ankle, and secured to the hole in the lower end of the outer splint.

Dr. Physick's modification, (Fig. 228), consists in an elongation of the outer splint, nearly to the axilla; by this means counter-extension is made in a line more nearly parallel with the axis of the body. A block was placed by Dr. Hutchinson upon the inner side of the lower end of the same splint, below the foot, for the purpose also of preventing the line of extension being oblique, which might produce pain and deformity. Bags of bran are placed on each side of the limb, so as to secure uniform pressure from the splints, and the whole is secured by

bandages. Another improvement consists in uniting the extending and counter-extending bands on the outside of the outer splint. By twisting these bands the extending force may be increased to any extent.

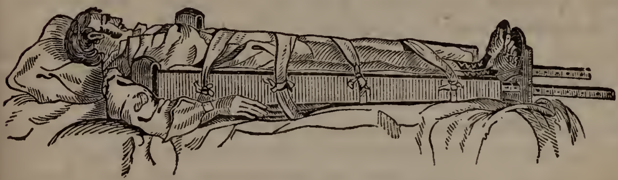
Hagedorn's Apparatus consists of one splint reaching from the hip to a foot-board.

Fig. 228.

The counter-extension is made at the acetabulum of the sound side, and the extension by the foot of the injured side. The splint is first applied to the outer side of the sound limb, and the foot secured to the foot-board; and the extension is made by drawing the foot of the fractured limb down to the foot-board, and securing it. This avoids the necessity of a perineal band, which may excoriate.

Dr. Gibson's modification (Fig. 229) of this apparatus

Fig. 229.



consists in an elongation of the splint as high as the axilla, which will prevent any lateral inclination of the body; and the application of a similar splint to the fractured limb.

FRACTURE OF THE PATELLA. (FIG. 230.)

The accident may result from muscular contraction or direct violence. It is sometimes attended with an audible snap and falling of the patient; the pain is not severe, and a simple fracture is not dangerous. The limb is bent partially, and there is no abilty to extend it.

Fig. 230.

The direction is usually transverse, and a separation of the fragments can be felt. There is no crepitus. Considerable swelling usually follows.

Longitudinal fractures are rare, and are not attended by the same symptoms.

Treatment. — Leeches and lotions should be applied to reduce swelling and inflammation. By means of strips of adhesive plaster, the fragments can be coapted, and firmly retained in apposition. A long splint, reaching from the ischium to the heel, applied to the back of the limb, will prevent motion.

Bony union is not to be expected; a strong ligamentous connexion

is usually formed, which answers the purpose extremely well. Passive motion should be made after five or six weeks. Sixty or seventy *days* will elapse before the limb can be used; and even then, caution should be taken that the newly-formed ligament be not broken. The patella of the opposite side is liable to fracture; for it possesses the same structure which predisposed to fracture in the other limb, and there is increased muscular exertion of the sound limb.

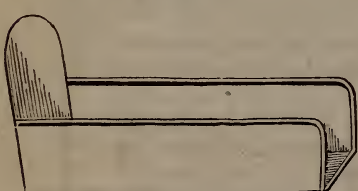
FRACTURE OF THE LEG.

A frequent accident, occurring in one or both bones, from a fall or direct violence. The *tibia* is most frequently fractured, on account of its exposed position, and its sustaining the weight of the body. The fracture may occur at any part, but the deformity is greater, as it may be nearer the lower extremity; if nearer the upper extremity the deformity may be slight and the patient even be able to walk about.

The fibula may be fractured by direct or indirect force. Little deformity results, unless the fracture is below its middle. When nearer the ankle, dislocation may be produced. The most frequent seat of fracture is from two to three inches above the malleolus. There is immediate lameness; the foot is turned out; crepitus is distinct, and a depression exists over the fractured part.

Both bones are often fractured at once by falls or blows; they occur at the weakest points. The signs are evident: crepitus, pain, want of motion, &c. There is seldom any great shortening, and the deformity is very evident.

Fig. 231.



Treatment.—When both bones are fractured, when the tibia alone is fractured, or, when the upper part of the fibula is fractured, the best and most simple apparatus is the fracture-box and pillow. The box (Fig. 231.) has a foot-board, to which the foot is secured by a bandage, thus preventing any lateral inclination. In lieu of this, two splints of the length of the leg, applied on either side of the pillow, will answer the purpose, care being taken to support the foot by a bandage or handkerchief.

Fig. 232.

Fractures of the lower end of the fibula may occasionally require Dupuytren's apparatus (Fig. 232), consisting of a single splint, placed on the inner side of the leg, and reaching beyond the foot. It is provided with a wedge-shaped pad, which reaches only to the ankle, the larger end of which being applied to the internal malleolus; a bandage is carried over the ankle in such a manner as to produce inversion of the foot, making the sole of the foot approximate the splint, and thus the fragments are adjusted and the deformity removed.

FRACTURES OF THE BONES OF THE FOOT.

The *os calcis* may be fractured by great violence connected with the action of the sural muscles. The tuberosity will be drawn up by the tendo Achillis, and the patient is unable to stand.

The *treatment* consists in overcoming the action of the triceps suræ, flexing the leg upon the thigh, and extending the foot upon the leg. The fragments are to be approximated by a figure of 8 bandage.

The *astragalus* is rarely fractured; it may occur at the posterior part where the tendon of the flexor longus pollicis plays over it; or it may occur between the body and the head. In the first instance the foot will be inverted, in the latter but little deformity will occur.

It can be *treated* successfully by a simple fracture-box. Should caries take place it may become necessary to extirpate it.

The *metatarsal* bones and the *phalanges* are seldom fractured, unless the injury be complicated or compound.

COMPOUND FRACTURE.

Unless a wound communicate with the fracture, it is not compound. The wound may be produced by the means which broke the bone, by the bone protruding, or by subsequent ulceration. Great danger may result from the shock, hemorrhage, tetanus, suppuration, hectic, or typhoid fever.

Primary amputation is necessary if the bone is much shattered; if a joint, especially the knee-joint, is opened; if large arteries are torn; if the soft parts are extensively lacerated or bruised, particularly if the patient is old or enfeebled by disease.

The *treatment*, if it be determined to try to save the limb, will be to convert the fracture into a simple one, by arresting bleeding, removing pieces of bone, clots, &c., so the wound will heal without suppuration. To reduce the protruding fractured extremities, it may be necessary to saw off a portion; to arrest the hemorrhage, it may be useful to envelope the parts in bran, or stuff the opening with lint, which must be removed as soon as suppuration occurs.

The subsequent part of the treatment may require antiphlogistic, but more frequently tonic measures, such as bark, wine, good diet, &c., especially if the discharge is profuse. Secondary amputation may be necessary at last.

DISLOCATIONS.

Dislocation or luxation, is the removal of a bone from its articulating cavity. The ball and socket joints are most liable to the injury.

The *predisposing causes* are the peculiarity of the construction of the joint, weakness or paralysis of the muscles, elongation of the ligaments, particular position of the parts, accumulation of fluids in the joint, or diseases and fractures of the bones.

The *exciting causes* are external violence; such as blows, falls, &c., and muscular contraction.

The *symptoms* are deformity, swelling, and a hollow where none should be, shortening or elongation, pain and immobility of the limb.

The *consequences* are rupture of ligaments, effusion of blood and serum; lymph coagulates, forms new adhesions, and fills up the old socket, and the head of the bone gradually accommodates itself to its new position, there always being some attempt to form a new socket; and thus considerable motion is subsequently acquired by the limb.

Dislocation is to be distinguished from fracture by the absence of crepitus, the rigidity of the limb, the peculiarity of the deformity at the articulation, and by the absence of deformity after reduction; whereas in fractures it will recur without being prevented by dressings.

Treatment.—This essentially consists in overcoming the action of the muscles which retain the bone in its unnatural position, and also in bringing the head of the bone into such a situation that the action of the muscles may draw it into its place.

Constitutional means are often necessary to effect reduction in the larger joints, such as bloodletting, warm baths, emetics, in order to produce relaxation of the muscles. The local means are extension and counter-extension. The extension must be made gradually, in order to overcome the action of the muscles, and to place the head of the bone in such a situation as to be drawn into its place, and the extension must be withdrawn suddenly, in order that the muscles may have the effect by their contraction.

The treatment subsequent to the reduction consists in maintaining the limb at rest, and applying leeches and cold applications to remove swelling and pain. Afterwards, if any stiffness remains, stimulating friction may be used.

Subluxation implies a partial removal of the head of a bone from an articulating surface. *Recent* and *old*, are terms applied to luxations with reference to the period which may have elapsed, and the changes which may have occurred by adhesions, &c.

Compound Luxation.—This is connected with a wound in the integuments, fracture of bone, laceration of large vessels, &c. The same principles apply as in compound fracture. The same contingencies of age, temperament, and constitution, will influence the treatment. The question of amputation is first to be considered, and then the reduction. The after treatment would be that for a wound of the joint: careful closure of the wound,—prevention of inflammation by antiphlogistic means; if possible preventing suppuration, anchylosis, and tetanus.

DISLOCATION OF THE JAW (FIG. 233).

Fig. 233.

Dislocation of the jaw may be caused by spasm of the pterygoid muscles when yawning, or by a blow on the chin when the mouth is wide open. The condyles are pushed forwards, and rest in front of the base of the zygomatic process of the temporal bone.

Symptoms.—The mouth gapes and cannot be shut, the glenoid cavity is vacant, and there is a prominence felt beneath the zygoma; the saliva trickles, articulation is prevented, and there is great pain.

Treatment.—The patient should be seated on a low stool, and the surgeon standing in front, should press his thumbs, properly protected, upon the last molar teeth, at the same time elevating the chin with the fingers. The condyles are thus extracted from their unnatural position, and returned to their socket by the normal action of the muscles, which produces an audible noise. In difficult cases, greater leverage may be obtained by using two forks or strong pieces of wood, connected by a string in such a way that it will elevate the chin, whilst the ends are pressed against the teeth in place of the thumb. When the resistance is great the efforts may be directed first to one side at a time. Still greater power may be obtained by the use of Hiester's screw.

After reduction, the chin should be confined by a bandage for a week or ten days.

DISLOCATION OF THE SPINE.

This accident rarely happens unless connected with fracture; although it has occasionally occurred in the cervical vertebræ.

It may be produced by the muscular effort of convulsion and mania, but more frequently is the result of violence; for instance, falls from a height, crushing by wheels, hanging, &c.

The chance of life is but small on account of injury done to the spinal marrow. The displacement is easily recognised by the deformity, paralysis, &c.

Dislocation of the atlas upon the dentata may occasion instant death, by the intrusion of its tooth-like process into the spinal marrow. Dislocations of the oblique processes simply may terminate with no other inconvenience than contortion of the neck and restricted motion of the head. The action of the diaphragm may be suspended by compression of the phrenic nerve.

Dislocations of the bodies of vertebræ of the neck and back, are almost necessarily accompanied by fracture.

Treatment.—But little is to be expected. Great care is required in extension and coaptation. In the neck, danger is to be apprehended from an attempt to reduce the deformity. Contusion of the muscles may produce a deformity which may resemble dislocation.

Subluxation or *partial* dislocation is more common; and it may terminate without permanent injury to the spinal marrow; provided the antiphlogistic system is pursued in all the details of rest, diet, purging, cups, &c.

DISLOCATION OF THE RIBS.

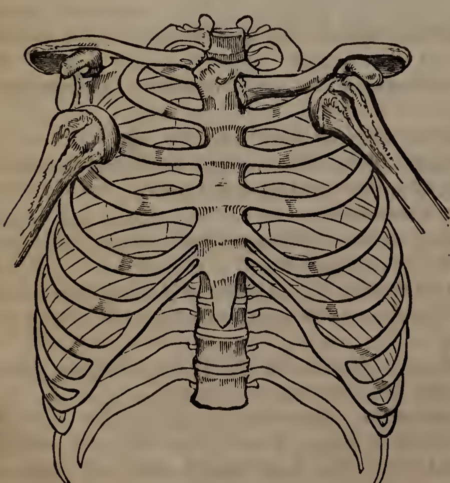
The *vertebral* extremity of the ribs can only be dislocated by severe falls, or blows upon the back, on account of its double articulation, and its protection by the muscles of the back. The *sternal* extremity is sometimes loosened from the cartilage by violent bending of the body backwards;—great pain and difficulty of breathing follows. Reduction can be effected by deep inspiration, slightly bending the body backwards and making some pressure on the projecting point. The subsequent treatment is the same as that for fracture of the rib.

DISLOCATION OF THE CLAVICLE.

The clavicle may be dislocated at either extremity, and is more rare than fracture.

The *sternal* end may be dislocated upward, backward, and forward. Fig. 234.) When dislocated upward, the sternal extremity approaches its fellow, and is much more elevated than the acromial extremity. When dislocated backward, which is more rare, there is a depression over the articulation, pain and stiffness in the neck, and difficulty of swallowing. When the direction is forward, which is the most frequent, it is produced by force applied at the opposite extremity. It is characterized by a projection over the spot, inclination of the

Fig. 234.



head to the affected side, pain upon moving the arm, and the shoulder is brought near to the chest.

The *reduction* is easy,—by means of extension and counter-extension; there is more difficulty in preventing a recurrence of the accident. Desault's apparatus for fractured clavicle should be applied. But even with the greatest care, greater or less deformity commonly remains, which, however, does not interfere with the motions of the arm.

The *scapular* end is generally dislocated upwards. Although sometimes it slides beneath the acromion. It is usually the result of a fall; and is recognised by pain, impeded motion, depression of the shoulder, and the clavicle resting on top of the acromion occasions a projection.

Reduction is effected by elevating the shoulder and depressing the corresponding end of the clavicle. Desault's bandage is then to be applied, and the part kept at rest. Some displacement usually remains, which does not prevent motion of the shoulder.

DISLOCATION OF THE ARM (FIG. 235).

This is the most frequent dislocation, on account of the mobility of the shoulder joint, its constant exposure to injury, and the shallowness of the glenoid cavity, compared to the size of the head of the humerus.

It may be displaced in three directions; viz., inwards, downwards, and backwards. In dislocation inwards, the elbow stands out from the body, and is inclined a little backward: a protuberance is felt beneath the pectoralis major muscle, aud there is frequently shortening of the limb.

In dislocation downwards, which is the most common displacement, the arm is lengthened, and there is great rigidity and immobility; the elbow stands out from the body; there is a hollow under the acromion process, and a prominence in the axilla.

In dislocation backward, which is most rare, the elbow is inclined inward and forward, the head of the bone forms a prominence beneath the spine of the scapula, and there is a hollow beneath the acromion, together with rigidity and immobility.

Violence and contraction of the muscles pectoralis major, latissimus dorsi, teres major, and deltoid, are the causes of dislocation of the arm. The immediate injury is a laceration of the capsule, contusion of the muscles, and effusion of blood, and often paralysis of the deltoid muscle from compression of the axillary nerve. Unless reduction is effected the parts become united by adhesions,—after which reduction cannot be produced without danger of lacerating the artery.

The *reduction* is managed in different ways. After etherising the patient, the ordinary plan is to place him on the bed, and then to place a spherical pad in the axilla. The surgeon makes counter extension with his foot upon the pad. and extension with his hands. If

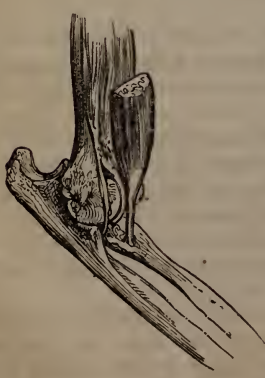
Fig. 235

this force is not sufficient, counter-extension may be made by passing a folded towel or sheet under the axilla, and securing the ends to the bed-post; and extension by fastening a folded sheet or long towel to the wrist or elbow by a damp roller; thus several assistants can make extension at once. If this force is not sufficient, pulleys may be employed, taking care that the extension be made very gradually.

The elbow has this advantage over the wrist, as a point of application of the extending band,—the elbow can be bent, and thus a greater rotatory movement of the head of the bone produced. The wrist is preferred by some on account of there being no muscles compressed, whose contraction might interfere with the reduction.

After reduction, which is recognised by cessation of pain, rotundity of the shoulder, and mobility of the limb, the arm should be kept in a sling, and not used for several days. Should paralysis of the deltoid continue, it may be relieved by stimulating lotions, blisters, moxas, &c.

Fig. 236.



DISLOCATIONS AT THE ELBOW (FIG. 236).

When both radius and ulna are dislocated at the elbow, the forearm is bent nearly at a right angle, and is immovable. The olecranon forms a prominence behind, and the articular extremity of the humerus, covered by the brachialis anticus muscle, forms a protuberance in front. The coronoid process of the ulna is received into the greater sigmoid cavity of the humerus, and tends

to maintain the bones in their unnatural situation. A *lateral* dislocation inwards may also occur, in which there is a great projection of the external condyle of the humerus, in addition to the symptoms of the first variety.

When the ulna alone is dislocated backwards, the olecranon forms a marked projection posteriorly, the elbow is bent at right angles, and the forearm is pronated.

Reduction of the above forms of dislocation is effected by making forcible extension of the forearm over the surgeon's knee, which is to be placed at the elbow, to make counter-extension. The forearm is to be bent while extension is produced.

The *radius* is dislocated at its upper extremity, either forwards or backwards. Backwards is the most frequent displacement. The head of the bone forms a prominence behind, the arm is bent and the hand is prone. When displaced anteriorly, there is a distinct prominence in front, the arm is slightly bent, but cannot be completely flexed, and there is some supination.

The *reduction* is effected by making forcible extension and pronation at the same time, if the displacement be anteriorly; if the displacement be posteriorly, supination is to be produced with extension. In both, the head of the bone is to be pressed upon by the surgeon's thumb, in order to facilitate its sliding into its proper place.

Dislocation at the elbow occurs but rarely, on account of the ginglymoid character of the joint, and is generally acompanied by considerable laceration of the soft parts. Rest, cold applications, and a sling, are subsequently required, together with general antiphlogistic means.

It is produced, most frequently, by force applied to the wrist, and when complicated with fracture of any of the processes, anchylosis, gangrene, and other dangerous results may follow, especially if the reduction is delayed, and adhesions have formed.

DISLOCATIONS AT THE WRIST.

The *radius* and *ulna* have rarely been separated from the carpus, either anteriorly or posteriorly. When dislocated *forwards*, there is a great projection in front, and the hand is bent backwards; when backwards, the projection is behind, and the hand is flexed.

It is produced by violent bending of the hand, and is accompanied by rupture of the ligaments and stretching of the tendons. The *reduction* is easily effected by extension and pressure. Pain, swelling, and stiffness of the joint may follow, which are to be obviated by cold applications, rest, lotions, &c.; if there should be a tendency to its reproduction, a light splint may be applied.

If the *radius alone* is dislocated from the carpus, which is generally anteriorly, the hand will be somewhat twisted, the radial side of it being thrown backward. The *ulna* may be dislocated backwards upon the radius, rupturing the sacciform ligament, and producing a supina-

tion of the hand, a projection on the back of the wrist, by which it is easily recognised. It is readily reduced by pressure and extension. A splint and bandage may be necessary to prevent its recurrence.

DISLOCATION OF THE BONES OF THE HAND.

Displacement of the bones of the *carpus* rarely occurs. Occasionally there is a dislocation of the *phalanges* (Fig. 237) of the fingers, but more frequently the dislocation backwards of the first phalanx of the thumb upon the metacarpal bone.

Fig. 237.

Reduction is effected by making extension in a curved line, by means of a narrow bandage or tape, firmly applied by a clove-hitch upon the phalangeal extremity. In some instances it may be necessary to divide the lateral ligament.

DISLOCATIONS OF THE FEMUR.

Dislocations of the thigh may occur in five directions:—1st, upwards and backwards, on the back of the ilium (Fig. 238); 2d, inwards and downwards, into the foramen ovale (Fig. 239); 3d, backwards, into the ischiatic notch (Fig. 240); 4th, upwards and forwards, on the horizontal ramus of the pubes (Fig. 241); 5th, downwards, under the tuberosity of the ischium. The first is the most common, the fifth is the most rare.

In the most frequent displacements *upwards and backwards* (Fig. 238), the limb is shortened an inch and a half to two inches and a half; the toes rest on the opposite instep; the knee is turned inwards and slightly bent; the limb may be bent across the other, but cannot be moved outwards; the trochanter is less prominent, and nearer the spine of the ilium; and if the patient is thin, and there is no swelling, the head of the bone can be felt in its new position, and the rounded form of the hip is lost. It is to be distinguished from a fracture of the neck of the bone by the position of the foot and the rigidity of the limb.

Treatment.—The reduction is the most difficult of all dislocations, and must be attempted as soon as possible after the displacement. If it is not produced, the head of the bone will adapt itself to its new position by the formation of a new cavity, and the patient will gradually be able to walk, the toes merely touching the ground. Bleeding, a

warm bath, and tartar emetic, remedies which were formerly administered to produce relaxation of the muscles, have given place to etherization. Counter-extension is to be made by a folded sheet or large towel placed in the perineum, the patient being in the recumbent position, and secured to a ring or hook firmly fastened in the wall or floor.

Fig. 238.

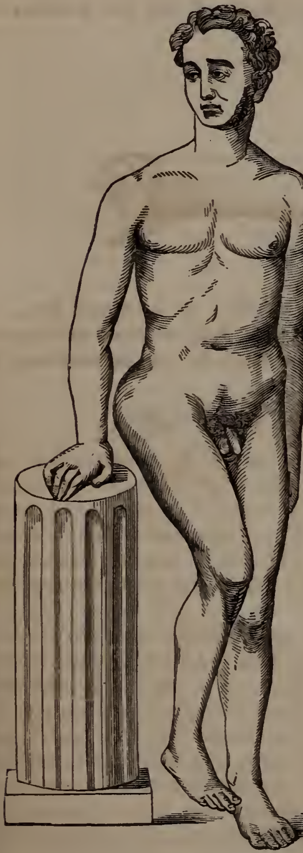


Fig. 239.

Extension is to be effected by securing a folded towel or sheet above the knee, by means of a damp roller; this towel is to be acted upon gradually, by numerous assistants or by pulleys, (Fig. 242.) The extension is to be made gradually, in such a direction as to draw the thigh across the opposite one. a little above the knee. A third band or towel

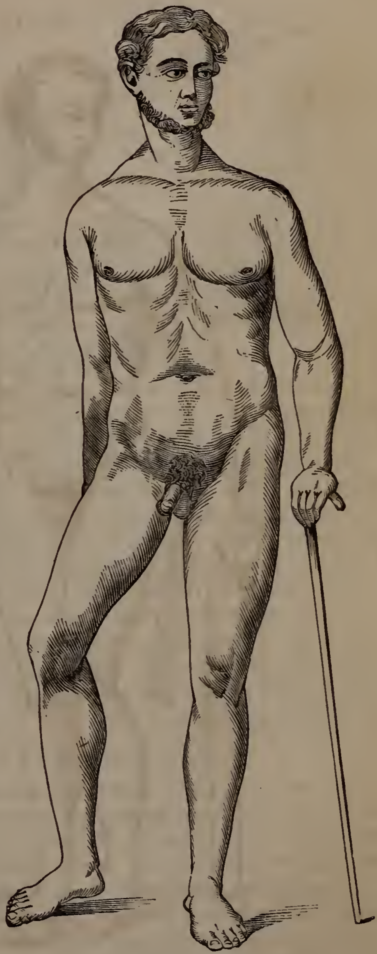
is to be passed around the pelvis, in order to fix it more firmly, the ends of which are to be tied on the sound side, which is to be given to an assistant. The proper manipulation of the head of the bone is of more importance than great extending force.

Fig. 240.

Dislocations *backwards* in the sciatic notch (Fig. 240) are next in frequency. The head of the bone rests on the pyriformis muscle, between the sacro-sciatic ligaments and the upper part of the notch, a little above the level of the middle of the acetabulum. The shortening and inversion of the foot is not so great as in the first variety; the

head of the bone can seldom be felt; the joint is extremely rigid, and motion of the limb almost impossible. In reducing this dislocation it is necessary that the head of the bone should first be brought out of the notch, before it can be restored to the acetabulum.

Fig. 241.



Dislocations *downwards and inwards* are comparatively rare; the limb is elongated nearly two inches; the foot is advanced, though neither inverted or everted; the thigh is abducted, and cannot be brought near to its fellow; the psoas and iliacus muscles form a ridge which can be seen or felt; the trochanter is flattened and depressed, and the space between it and the anterior superior spinous process of the ilium is much increased. To reduce this form, counter-extension is to be made outwards by a band across the upper and inner part of the thigh: extension is to be made at the knee, which is gradually to be made to approximate its fellow.

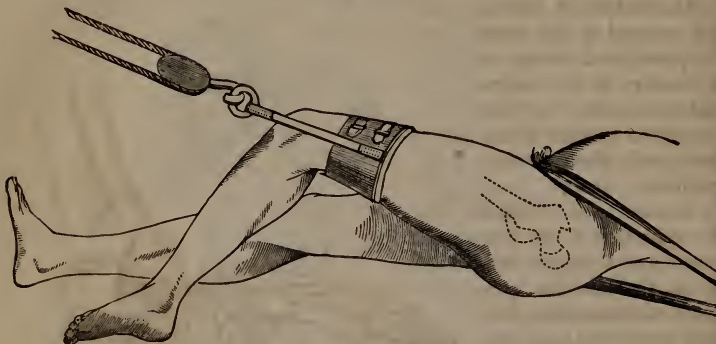
In dislocation *upwards and inwards* (Fig. 241), the head of the bone rests on the horizontal part of the pubes, under Poupart's ligament, where it forms a tumour. The limb is shortened an inch, and the foot is turned outward, and cannot be rotated. The reduction is effected by extension in the axis of the body.

Reduction of the thigh is indicated by an audible noise when the head of the bone returns to its socket, by the natural length and direction of the limb, by the cessation of pain, and the free motion of the joint.

After reduction there is sometimes a slight elongation of the limb, which depends upon the swelling of the ligaments of the joint. The

patient should be kept at rest, and may require antiphlogistic treatment; walking should not be attempted for several weeks.

Fig. 242.



DISLOCATIONS OF THE KNEE.

Dislocation at this joint is rare on account of its great strength. The displacement may be forwards, backwards, and laterally; it is usually incomplete and readily reduced.

The reduction is accomplished by extension of the leg and coaptating the extremities of the bones. Subsequent inflammation and its results, anchylosis, suppuration, &c., are to be avoided by strict antiphlogistic means; sustaining the weakness of the joint by splints or rollers, and removing the stiffness by lotions and frictions.

The *semilunar cartilages* are sometimes displaced by twisting the joint, especially if an unusual relaxation of the ligaments should exist. The limb is immediately rendered stiff, and the pain is severe and sickening. Extreme flexion usually is sufficient to restore the parts to their position, although the pain and swelling remain for some time, and require attention.

DISLOCATIONS OF THE PATELLA.

The patella may be dislocated anteriorly, posteriorly, and laterally. *Outwards* is the most frequent displacement, and it is characterized by the leg being stretched, a prominence externally formed by the patella, and a projection internally of the internal condyle.

Reduction is effected by raising the leg and resting the patient's heel on the surgeon's shoulder, thus relaxing the muscles of the thigh; at the same time the patella is to be forced into its place with the hand. This bone can only be displaced *upward* by a rupture of its tendon, and *downward* by a laceration of the rectus muscle. It may be displaced by semi-rotation, one edge resting on the trochlea of the femur, and the other forming a prominent ridge. Extreme flexion and coaptation will reduce it.

DISLOCATION AT THE ANKLE (FIG. 243).

This accident is usually the result of severe force, and accompanied by fracture of the malleoli. The displacement may be forward, backward, inward, and outward.

Fig. 243.

Dislocation of the tibia *inward* is the most frequent, and owing to a fracture of the external malleolus, the foot is everted and the internal malleolus greatly projects.

Reduction is effected by extension of the foot and flexion of the leg, so as to relax the gastrocnemius muscle. Dislocation of the tibia outward is occasioned by a fracture of the internal malleolus, and the deformity is the reverse of the last. Dislocation backwards may result from a fracture of the posterior extremity of the astragalus, in which instance the foot is inverted as in varus; this is more rare than dislocations forward, which result from fractures of the lower end of the fibula. There is danger of suppuration and gangrene, especially if connected with an external wound. Amputation will often be the best resort, particularly when the constitution of the patient is bad.

DISLOCATION OF THE BONES OF THE FOOT.

The *astragalus* is more frequently dislocated than any bone of the tarsus; and it may either be forward or backward. Unless reduction can be effected, which is difficult, excision of the bone may be necessary, or amputation at the ankle. Dislocation of the other bones of the tarsus are usually compound injuries, and are to be treated upon general principles.

INJURIES OF THE HEAD.

THE SCALP.

Contusion of the scalp may be very severe, on account of its being stretched over the resisting bony surface of the cranium, and being frequently connected with a lacerated wound. Owing to its vascularity, great swelling will occur from extravasation of serum or blood; in many instances a fluctuating tumour being produced beneath the integuments. The swelling which results being readily depressed in

the middle, may give rise to the idea of a fracture, which is to be carefully diagnosticated.

The *treatment* will require cold applications. In no instance is a coagulum of blood to be evacuated by incision or puncture; but absorption is to be promoted and depended upon, even if slow and tedious. It may be that the clot will produce inflammation and suppuration; then a free incision should be made, and the exit of the pus favoured. Healthy granulation contracts the cavity, and the wound unites by the formation of a cicatrix.

The constitutional treatment required may be different in the early stages from the latter, being antiphlogistic or tonic, as the symptoms demand.

WOUNDS OF THE SCALP.

Simple incised wounds of the scalp give little trouble but that of hemorrhage, which is best arrested by a ligature, compression, or torsion; a curved needle will be found more convenient to secure the vessels than the tenaculum. The edges are to be drawn together by adhesive straps, in preference to stitches, on account of the danger of erysipelas. When a large portion of the scalp is lacerated, and hangs like a flap, it is not to be cut, even though it is attached by a very small process; but, after being carefully cleaned, it is to be adjusted accurately, and retained in its place by proper bandaging. It thus protects the bone from exposure, and by granulation may become firmly united to the adjacent parts. Blindness may result from a wound upon the forehead by injuring the supra-orbital nerve, or from concussion of the ball of the eye.

CONCUSSION.

By this is meant a jarring or shaking of the brain without any great lesion, though function is temporarily impaired; inflammation is apt to follow. The force may be directly from a blow upon the head, or indirectly, from alighting upon the feet. The patient is stunned, is somewhat insensible, lies motionless, pale and cold. Insensibility is not complete, for questions will be answered, and pain manifested by pinching; respiration is feeble, the pulse is rapid, small, and fluttering; the pupils are insensible to light, sometimes contracted, and sometimes dilated; nausea and vomiting often follow. After reaction, inflammatory symptoms commence, the pulse becomes full and hard, the skin hot and dry, the face flushed, the eyes bloodshot, great pain, especially in the head, restlessness and delirium.

Treatment.—In the first stage, that of prostration, the chief care of the surgeon is to prevent some bystander from bleeding the patient, in common with the vulgar notion. No active treatment should be resorted to until reaction has taken place. In the mean time the patient should be undressed and put to bed, and his limbs carefully examined; the head should be shaved, wounds dressed, &c.

Should the prostration continue, and danger impend from syncope,

stimulation is to be resorted to in the most gradual and cautious manner; warm frictions are to be employed, small quantities of tea, wine, and water are to be administered with care, lest they pass into the air-passages, and produce asphyxia. After reaction commences, stimulants are to be suspended, lest they increase subsequent inflammation. By hurrying on reaction, life is often endangered, as by the too early abstraction of blood. So soon as inflammatory symptoms fairly manifest themselves, we should endeavour to repress them by excluding all kinds of excitement, especially light and noise, and by the application of ice and evaporating lotions to the head, which should be elevated upon pillows. If great reaction occur, manifesting itself by delirium, convulsive movements, a full and active pulse, pain, &c., local and general bleeding, together with enemata and purgatives, are to be resorted to; opium will also have a beneficial influence if administered judiciously, especially in connexion with calomel and tartar emetic. For some time after the violence of the inflammation has subsided, the brain remains weak and requires watchful care; excitement, both physical and mental, is to be avoided, the diet regulated, and the head kept cool. The memory is often impaired, the conversation childish and incoherent, the eye wild and vacant in its expression, the demeanour either most timid and gentle, or entirely the reverse; occasionally one or more of the special senses, such as hearing or smell, is lost; such consequences may be temporary or permanent. The treatment most suitable is a mild mercurial course, long-continued counter-irritation, regulated diet, avoidance of all excitement and exposures to changes of weather, together with the use of the cold shower-bath.

FRACTURES OF THE CRANIUM.

These occur more frequently in adults than in children, on account of the unyielding and brittle nature of their bones, whereas the bones of a child's head are pliable, and yield to the force without fracture. Fractures of the cranium are classified, by the extent of injury, into simple fissure, stellated, depressed, and camerated fractures, fractures of the external or internal table, &c. The dangers attendant are various; there may be concussion, compression, hemorrhage, and inflammation of the brain and its membranes.

A simple fissure is of but little importance, even should it be extensive, and traverse a suture, which it often does. The fracture itself requires no treatment, unless accompanied by symptoms of concussion, compression or inflammation.

Fracture at the base of the cranium is a very serious injury, and usually attended with laceration of the membranes, and internal hemorrhage. It is usually suspected, from the early appearance of symptoms of compression, the manner in which the injury was received, escape of blood from the ears, and sometimes from the nose and mouth. The latter symptom, although generally considered a most

dangerous one, may be the result of mere laceration of the lining membrane of the ear or the nose. The treatment required will be that for inflammation or compression.

A DEPRESSED FRACTURE.

This is to be carefully diagnosticated from a fracture of the external table alone, and from a depression in the middle of a tumour occasioned by the effusion of lymph. It is dangerous, from the complications of concussion, compression, extravasation of blood, and inflammation. The treatment consists in removing the cause of compression, and combating the effects of inflammation; the former by the operation of trephining, and the latter by strict antiphlogistic means.

COMPRESSION.

Compression may be the result of extravasated blood, depression of the bone, or the formation of pus The symptoms which characterize it are slow, laborious, stertorous respiration; a full, regular, slow pulse, and complete loss of consciousness and sensibility; the muscles are relaxed and powerless, pupils dilated and insensible, the skin warm and moist, and the sphincters often relaxed. The patient may perish immediately from coma, or may rapidly recover from the removal of the cause of depression.

Extravasation of blood may take place immediately upon the infliction of the injury, or not until reaction has followed; concussion often being produced at the same time. The extravasation may be situated between the bone and the dura mater, which is the result of a wound of the meningeal artery. This may be the result either of a direct blow, or of a counter stroke. The symptoms gradually appear, and if urgent, the trephine should be used, and the blood, if fluid, escapes at once. If the symptoms be not severe, the clot may be absorbed, and the brain gradually recover from the compression, provided high inflammatory action is prevented.

Blood may be effused within the membranes, or within the ventricles; most frequently being the result of injury to the vessels of the pia mater. The clot effused *within* the membranes is usually larger, and will produce more dangerous symptoms than one *external* to them. The most dangerous consequences result from a clot at the base of the brain.

Treatment.—The objects are to prevent increased effusion and diminish subsequent inflammation, and the removal of the clot. The head should be elevated, cups and cold applications applied, with general bloodletting and purging. The action of the heart is to be diminished, in order to prevent the further extravasation of blood. The removal of the clot is accomplished by trephining, and opening the membranes. If, however, the clot is at the base of the cranium, or it is uncertain where it may be, the membranes are not to be opened, for

the chances of inflammation would be much increased by the operation, and the cause of compression not certainly removed.

Compression resulting from the formation of pus, does not exhibit the ordinary symptoms rapidly, as in the case by the escape of blood, nor do the symptoms subside so readily; because pus is not so amenable to absorption as blood. It cannot be discharged but by the exfoliation of the bone, which is a tedious process. The symptoms denoting the formation of this dangerous abscess, affect the system as well as the part; and the patient would manifest the same restlessness, rigor, and fever, which attend the formation of pus in other parts of the body.

Conditions which justify the operation of trephining.

1. In simple fracture with depression, provided the symptoms persist after the use of depletion, purging, and the other alleviating remedies.

2. In compound fracture with depression, without symptoms of compression

3. In punctured fracture without symptoms of compression.

4. When the symptoms are very urgent, and the surgeon thinks he has good reason to believe that they are caused by blood or purulent matter underneath the cranium and above the dura mater, or by fracture with depression of the inner table.

TREPHINING.

The scalp is first to be cleanly shaved; and if a wound already exist, the cranium may be exposed simply by enlarging it; but if no previous wound exist, an incision is to be made, of a crucial, triangular, or semicircular shape,—the latter being most preferred. The pericranium is then to be detached by a scraper, unless the trephine have an additional means for removing it. That portion of the cranium should be selected which is sufficiently near the injured parts to allow of elevation of the fragments, by the introduction of an elevator, and at the same time to be sufficiently firm to bear the pressure of the trephine. The sinuses of the dura mater, the occipital cross, and the course of the middle artery of the dura mater, are to be avoided. The centre-pin of the trephine is to be withdrawn after a groove is made sufficiently deep for the play of the teeth of the instrument; and great care is to be taken, lest the trephine saw through the bone unequally, owing to the want of parallelism of the two tables of the skull. The progress of the operation is to be cautiously watched, and the depth of the groove made by the trephine, ascertained by a toothpick or a small probe. The button-like portion of bone frequently comes away in the trephine; if not, it is to be removed by a forceps or elevator; the rough edges, (should any exist) of the internal table, are to be taken away by an instrument called a lenticular. Through the opening thus made, the elevator may be introduced, or the extravasated blood may escape. The opening is subsequently filled up by a dense membrane, formed

by the pericranium and dura mater. The edge of the opening is somewhat altered by absorption, and some deposit of bone. In some instances of compound fracture of the skull, a prominent angle may be sawed off with Hey's saw, and thus an opening be formed sufficiently large for the admission of the elevator, or the exit of the bloody clot.

INJURIES AND DISEASES OF THE FACE, NOSE, AND MOUTH.

Wounds of the face are usually attended with considerable hemorrhage, which sometimes requires the tying of an artery. Care is required to approximate the edges, in order to prevent deformity, and an ugly cicatrix. When the supra-orbital nerve is injured, vision is impaired; when the portio dura nerve is cut, paralysis of the muscles upon one side of the face results.

WOUNDS OF THE EXTERNAL EAR.

Do not affect the hearing; but when the cartilage is cut, a split will remain, unless the integuments are carefully united.

WOUNDS OF THE EYEBALL.

Produced by great violence, such as gun-shot wounds, of course destroy the sight, and are often followed by a fungous growth, which requires removal and the substitution of a glass eye.

WOUNDS OF THE TONGUE.

Bleed very copiously, and there is some difficulty in arresting hemorrhage. This is to be effected by a ligature and styptics; and, if necessary, by the actual cautery. Sutures are necessary to approximate the edges of the wound.

SALIVARY FISTULA.

This results from a wound or ulcer of Steno's duct, by which the discharge of the parotid gland opens externally on the cheek, occasioning great inconvenience and deformity, and interfering with the processes of mastication and digestion. A cure is to be effected by making an opening through the mucous membrane of the cheek, that the saliva may enter the mouth, and by closing the fistulous orifice. The edges of this orifice will require caustic, or paring with a sharp knife, or the actual cautery, to make them unite, and the internal orifice is to be kept open by a tent.

EPISTAXIS.

This implies hemorrhage from the nostril, produced by injury, plethora, or diseased state of the blood and mucous membranes. The treatment will, in a great measure, depend upon the cause. The arrest of hemorrhage by external applications, is only to be made under certain circumstances; it will be effected by an upright position, cold applied to the head and back, astringents thrown up the nostrils, and

compression by lint. In some instances, the lint is to be introduced through the posterior nares, by means of Belloque's canula, or by a flexible catheter and a piece of string, where it must be allowed to remain for several days; in many instances, constitutional treatment is necessary.

FOREIGN BODIES IN THE NOSTRIL.

Peas, beads, and such like substances are often inserted by thoughtless children: and by unwise efforts at removal, they are more deeply lodged in the cavity. The surgeon is to inject a stream of warm water into the nose, which will wash away any coagula of blood, and loosen the foreign body; its position is to be discovered by a probe, when it can be extricated by a scooped end of a director or forceps. A pinch of snuff will sometimes dislodge it.

POLYPUS OF THE NOSE.

There are different varieties of polypi: the most common is a gelatinous, pyriform mass, attached to the mucous membrane of the turbinated bones. The patient has a sensation of a cold in the head, which is much increased in damp weather. It interferes with respiration, and frequently alters the tone of the voice. The sense of smell is also impaired, and deafness may be produced, should it occupy the orifice of the Eustachian tube. It may be removed by twisting it off by the forceps; and the hemorrhage is to be arrested by astringent injections and lint. *A dense fibrous polypus* is best removed by a ligature or wire, applied by means of a double canula, for the purpose of strangulation. *Malignant polypi* may be regarded as incurable.

LIPOMA OF THE NOSE.

Is a hypertrophied condition of the skin and fat of the apex, and alæ of the nose; seldom occurring but in aged free-livers. When the growth is large, it is to be removed by the knife.

OZÆNA.

Is an obstinate, profuse and fœtid discharge from the mucous membrane of the nose, with disease of the bones beneath. The disease often extends to the frontal sinus and antrum. In adults, it is often dependent upon syphilis, or the abuse of mercury; in children, upon scrofula.

The *treatment* will in a great measure be constitutional, although benefit and comfort will be derived from the use of astringents and chlorine washes, and promoting the free discharge of the matter.

ABSCESS OF THE ANTRUM.

May result from a blow, or the irritation of a decayed tooth. It is attended with permanent, deep-seated aching of the cheek, the pain often becoming intense, together with rigors and fever. The cavity bursts, either internally or externally, which gives great relief. The

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earlier that leeches and emollient poultices are applied, the better; but, after the cavity has become filled with matter, there is necessity for immediate puncture just over the third molar tooth; or, a tooth must be extracted, and a trocar pushed through the socket. The discharge of pus can be facilitated by syringing with warm water.

EPULIS.

Is a solid tumour of the gum, of a non-inflammatory character. It commences in the form of a seed-like excrescence upon the gums, between the interstices of the teeth. Being without sensibility, it may occasion but little inconvenience, except by its size. As it grows, it loses its dense fibrous structure, and may become fungous; sometimes it becomes malignant.

Treatment.— Nothing will suffice but complete extirpation of the adjacent portion of the gum and alveolar process. Several perfectly sound teeth may have to be drawn, in order to apply a fine saw, or bone-pliers. The hemorrhage is to be arrested by muriated tincture of iron, and pressure by lint.

PARULIS

Is a gum-boil; occasioned usually by a decayed tooth, or a stump, or a tooth whose nervous pulp had been destroyed previous to plugging. The swelling is slow at first, though the pain is intense while the pus is forming Unless the tooth is extracted, an opening will be formed through the alveolar process and gum, for the discharge of the matter, which may remain fistulous.

The *treatment* will consist of leeches and fomentations, and the speedy evacuation of the abscess, either by the abstraction of a tooth, or by puncture.

RANULA

Is a sac formed beneath the tongue, by an expansion of Wharton's duct, either from disease or obstruction. Inconvenience is felt in mastication, deglutition, and articulation.

The *treatment* consists of dilatation of the duct, or making an artificial opening. It is necessary to keep the orifice distended by a tent or loop of wire, until the cyst contracts to its normal size; otherwise it will be refilled.

WOUNDS AND AFFECTIONS OF THE THROAT.

INFLAMMATION OF THE TONSILS.

This is characterized by the rapid swelling of the part, great pain in deglutition, and fever. It is to be treated by bleeding, leeches, purging, and gargles. An incision made with a bistoury will unload the vessels, and give exit to any pus which may have been formed.

Chronic enlargement of the tonsil may result from inflammation, especially in scrofulous persons; deglutition is impeded, the voice is

rendered hoarse, respiration is noisy and laborious, and there may be deafness, from the obstruction of the Eustachian tube.

The *treatment* should consist of the internal and external use of iodine, astringent gargles, and the application of nitrate of silver. If these means fail, it should be removed by the knife, or with an instrument constructed for the purpose, such as Physick's or Fahnestock's.

ELONGATED UVULA.

This may be removed simply by a forceps and scissors.

STRICTURE OF THE ŒSOPHAGUS.

The œsophagus may have a permanent or spasmodic stricture.

Spasmodic stricture comes on suddenly, generally at meals, and is attended with pain, and a choking sensation. It depends on a weakened or hysterical state of the system, or neuralgia. Tonics, antispasmodics, and alteratives, are the means of cure, with proper attention to diet, and care to avoid swallowing food that is hot or imperfectly masticated.

Permanent stricture is a narrowing produced by inflammation of the mucous and cellular coats, which forms a firm ring generally opposite to the cricoid cartilage. It is most frequent in females, and has these symptoms: difficulty of swallowing, which gradually increases, and is never absent; pain in the chest and neck. It is a serious complaint, and may be followed by ulceration, salivation, vomiting of purulent matter, and death from starvation or irritation.

The *treatment* should consist of a mild course of mercury, combined with some anodyne, a seton between the shoulders, and the passage of a bougie, together with a weak solution of nitrate of silver applied to the surface.

FOREIGN BODIES IN THE ŒSOPHAGUS

Produce a sense of choking and suffocation, and may prove fatal.

Treatment.—The patient should be seated in a chair, with his head thrown back, and his mouth wide open; the surgeon should then introduce his finger, regardless of the attempts to vomit, ascertain the position of the substance, and if possible remove it by the finger, or by the assistance of curved forceps. A small sharp body, such as a fish-bone, may be got rid of by swallowing a large mouthful of bread; a large soft mass, such as a piece of meat, may be pushed down into the stomach with a probang; a rough and angular body, such as a piece of bone or glass, should be brought up, if possible, by long and curved forceps, or with a piece of whalebone, armed with a flat, blunt hook, or with a skein of thread, so as to form a number of loops. If the stomach is full, it should be emptied by an emetic, with the hope that the foreign body may be ejected with the food. It may be necessary to resort to the operation of œsophagotomy, which should be performed by making an incision as nearly opposite the foreign body

as possible, through the skin, platysma and fascia, and between the sterno-mastoid muscle and trachea. Care must be taken to avoid the carotid and thyroid arteries, and the recurrent nerve. A small opening should be made in the œsophagus, by cutting it upon a silver catheter, which should be passed down the throat, and made to project into the wound; the opening should be dilated, so as to prevent hemorrhage.

FOREIGN BODIES IN THE LARYNX AND TRACHEA.

Food may get into the rima glottidis, whilst a person is laughing and talking at a meal; and unless immediate relief is afforded, death will result. The surgeon may sometimes be enabled to remove it with his finger; but if not, the larynx or trachea should be opened, and a probe introduced through the wound, so as to push the foreign substance up into the mouth. A foreign body may be impacted in the ventricle of the larynx, or be loose in the trachea, producing spasmodic cough, difficulty of breathing, and pain; a small body may even pass into the bronchial tube, generally the right one. Laryngotomy, or tracheotomy, may be necessary. The *larynx* is opened by a longitudinal incision through the middle crico-thyroid ligament. The trachea is opened in the median line through the skin, fat, and fascia, at the lower portion of the neck. After the tracheal rings are made bare, the patient is directed to swallow; and while the windpipe is thus rendered tense and elongated, the scalpel is made to penetrate the lower part of the wound, with its back towards the sternum, and the rings are to be divided by cutting upwards. Care should be taken, in this operation, to avoid opening large veins, or any part of the thyroid gland. This operation is sometimes necessary for dyspnœa, when a conical curved tube should be introduced for the patient to breathe through.

WOUNDS AND AFFECTIONS OF THE NECK.

WOUNDS OF THE NECK

Are extremely dangerous, on account of the important parts injured, and are usually the results of attempted suicide.

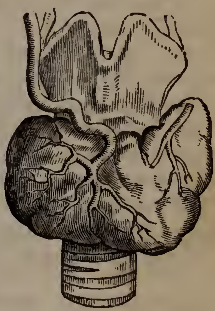
The *treatment* consists in arresting hemorrhage, obviating difficulty of breathing, and preventing inflammation. The arteries must be rapidly yet carefully tied, and the hemorrhage of the large veins restrained by pressure. If the larynx or trachea should be wounded, subsequent inconvenience may result from the introduction of cold air, clots of blood, &c.; if the pharynx or œsophagus is wounded, the use of a tube becomes necessary, in order to convey nourishment to the stomach. This tube must be introduced through the mouth, and not through the wound, as often as it may be necessary to supply the patient with food. The edges of the wound should be carefully drawn together, and dressed in the most simple manner, and should

be protected from unfavourable atmospheric influences by a covering of loose gauze, or of woollen texture thrown lightly over the neck. The patient should be carefully watched, to prevent a recurrence of the injury. A fistulous opening sometimes remains in the trachea or larynx, which is extremely difficult to heal.

BRONCHOCELE, OR GOITRE (FIG. 244),

Is a swelling of the thyroid gland, depending, for the most part, upon hypertrophy, although a cyst may be formed, or calcareous matter deposited. In certain localities, it is an endemic disorder, and often associated with cretinism. It occurs most frequently in females after the age of puberty. It grows gradually, and without pain, occasioning inconvenience merely by its deformity and bulk. Respiration is sometimes affected, and the venous blood being prevented from returning from the head produces cerebral disorder. The cause of the disease is obscure, but probably connected with climate.

Fig. 244.



The *treatment* will consist in the use of iodine, internally and externally, with attention to the general health; or it may be necessary, under the threatening of suffocation, to perform an operation. The removal of the gland is extremely dangerous, on account of hemorrhage, and does not always produce a cure.

TORTICOLLIS, OR WRYNECK.

This is a distortion of the neck to one side, generally the result of spasm of the sterno-cleido-mastoid muscle, or by a paralysis of the muscle of the opposite side. It may also result from tumours, caries of the spine, and cicatrices, especially those from burns.

The treatment will vary with the causes producing it. If it result from spasm, purgatives, leeches and fomentations should be used; if from paralysis of the opposite side, general tonic treatment and stimulating friction will be useful. If the contraction be permanent, the muscle must be divided.

INJURIES AND SURGICAL AFFECTIONS OF THE CHEST.

Wounds of the chest may be inflicted by a sharp instrument, a fractured rib, or a bullet. Danger results from hemorrhage, and subsequent inflammation from air, or clot of blood in the pleura. The intercostal may be the source of the bleeding, and it is sometimes difficult to arrest it by the ordinary means. A curved needle, armed with a ligature, is the best means of securing the vessel, when deeply con-

cealed in the intercostal groove. The entrance of air into the chest (pneumothorax) through the wound is to be prevented as much as possible by the early and accurate closure of the wound; otherwise there may be compression of the lung. The suppuration of the wound may lead to inflammation and suppuration of the pleura. This collection of pus in the chest is called empyema.

When the lung is wounded, there is still greater danger from hemorrhage, inflammation, and the air. It is attended with great prostration, difficult breathing, anxiety of countenance, and expectoration of blood. The danger of bleeding results not only from the direct loss, but from its collecting in the pleura (hæmatothorax), and its filling up the bronchial tubes and trachea. The inflammation may subsequently destroy the lung, and the life of the patient also by hectic. The air may also more readily enter the cavity of the chest, and not being readily discharged through the external wound, may infiltrate into the subcutaneous cellular tissue.

The hemorrhage is to be controlled by venesection, rest, and other antiphlogistic means. A careful examination of the wound should be made, in order that no foreign matters remain; the patient should lie on the wounded side, so as to favour the discharge of blood or pus, and it may also be necessary to prevent a closure of the wound. Emphysema may be overcome by compression, or an incision.

PARACENTESIS THORACIS.

Puncture of the thorax, may be required for accumulated air, blood, or pus. The opening is most frequently for empyema. The point selected is usually between the sixth and seventh ribs, half way between the spine and sternum. If made too low, the diaphragm may be wounded; if too high, the fluid will not so readily escape. The opening should be closed with care, to avoid the entrance of air.

WOUNDS OF THE ABDOMEN.

Wounds of the abdomen are extremely dangerous, on account of the important viscera contained within, and the liability to peritonitis. A simple wound of the parietes must be closed by suture if it is extensive, care being taken not to include a portion of the intestine. When complicated with a wound of the liver, fatal hemorrhage must almost necessarily result, on account of the great vascularity of the organ. A patient may survive a small wound, which will be succeeded by great prostration, pain in the liver, yellowness of the skin and urine, and a bilious discharge of the wound.

The *wounds of the gall bladder, and spleen, and urinary bladder,* if communicating with the peritoneum, are almost always fatal. Wounds of the *kidney* are also exceedingly dangerous from hemorrhage, violent inflammation, and suppuration, with excessive vomiting. Venesection, laxatives, warm bath, avoidance of drinks, with light dressings of the wound, are the proper measures for treatment.

PROTRUSION OF THE BOWEL.

When a portion of the intestine protrudes through a parietal wound of the abdomen, it is to be returned with great gentleness and accuracy, so as to avoid inflammation and obscure strangulation. The edges of the wound are to be carefully approximated, by suture if necessary, and by moderate bandaging such pressure is to be made as to prevent reprotrusion.

WOUND OF THE BOWEL.

A wound of the bowel may be suspected from the passage of blood with the stools, the escape of fæces through the wound, excruciating pain over the whole belly, and a great tendency to collapse.

Extravasation into the cavity of the peritoneum does not take place from a small wound, owing to the protrusion of the mucous coat through the muscular, and the constant and equable pressure of all the abdominal viscera; lymph is also rapidly effused, and the contiguous edges are thus united. If, therefore, the protruded part be found to have sustained a mere puncture, it is to be returned as if entire. An incision may be closed by the interrupted suture, care being taken to approximate the peritoneal surfaces; the ends are cut short, and the exudation of lymph envelopes the thread, which in time finds its way into the cavity of the bowel, and is thence discharged.

If the portion of bowel be bruised and lacerated to such an extent as to render adhesion impossible, and gangrene probable, the wounded part must be retained at the surface, and the peritoneal coat united with the integuments at one or more points; the fæces are thus discharged through the external wound, and an *artificial anus* is thus established.

WOUNDS OF THE STOMACH

Are recognised by vomiting of blood, and the nature of the matters which may escape from the wound. They are much more dangerous than those of the bowel. The edges of the stomach and the edges of the external wound are to be stitched together by the continuous suture. The subsequent treatment should consist of perfect rest, and the prevention of inflammation; venesection and leeches, and large doses of opium, will probably be necessary; nothing but thin arrow-root, or mucilage, should be given as a diet, and it may be necessary to administer this by the rectum: purgatives should be studiously avoided.

ARTIFICIAL ANUS.

This is an unnatural opening of the intestine, through which fæces are discharged. It may be the result of a wound, or sloughing consequent on strangulated hernia. The orifices of the upper and lower portion of the intestine are united with the abdominal wall. The lower portion of the bowel becomes contracted, and receives but little fæces. The integuments around the artificial opening form a funnel-

shaped cavity, the edges of which are red, everted, and excoriated. The *consequences* of the affection may be inanition by the escape of chyle, especially if the upper portion of the small intestine be engaged; a patient is liable to hernia, colic, besides the disgusting annoyance of the constant escape of fæces and flatus.

The *treatment* will consist of regulating the bowels by diet and medicine, and by supporting the orifice by a compress or truss, which will retard the escape of the discharge, and promote the contraction and cicatrization of the funnel-shaped cavity. It may be necessary to perform Physick's operation: this consists of introducing a ligature by means of a curved needle into the orifice of the upper intestine, and bringing it out through the orifice of the lower, which ligature is then to be secured with a slip-knot. The object of this ligature is to produce adhesion between the peritoneal surfaces of the upper and lower intestine: this will require several weeks; afterwards, an opening is to be formed through this adhesion by means of a bistoury, through which the fæces will pass from the upper to the lower intestine, the external orifice being firmly compressed with a truss. Dupuytren operated by means of a forceps, one blade of which was inserted into the orifice of each intestine, and the pressure regulated by a screw at the handle. The effect of the pressure of the two blades of the forceps, is first to produce adhesion between the sides of the two intestines, and by still greater pressure, to form an opening between them by ulceration.

HERNIA.

Hernia signifies a protrusion, but the term is usually limited to the protrusion of the abdominal viscera. The *predisposing* cause is a weakness of the parietes of the abdomen at the natural openings. This weakness may be increased by injury, disease, or pregnancy, and there may also exist a congenital deficiency.

The exciting causes are muscular exertion, jumping, straining, playing on wind instruments, coughing, vomiting, lifting weights, tight clothes, parturition, straining at stool, &c. *Hernia* is *divided*, according to the site of the protrusion, into *inguinal, ventro-inguinal, umbilical, ventral, phrenic, perineal, vaginal, pudendal, thyroideal,* and *ischiatic.* The *condition* of hernia is also a ground of division into *reducible, irreducible,* and *strangulated;* and if the contents of the sac be intestine, it is called *enterocele,* if it contains omentum, it is called *epiplocele.* The sac is formed of peritoneum, and its different parts are called mouth, neck, and fundus.

REDUCIBLE HERNIA.

Symptoms.—A painful swelling suddenly forms at some part of the abdominal parietes, which is compressible and soft, it can be made to disappear by pressure in the proper direction, and it often

disappears spontaneously. An *enterocele* is smooth, elastic, and globular, retires suddenly, and with a gurgling noise. An *epiplocele* is more irregular in its form, has a doughy feel, and retires slowly without noise.

Treatment. — The treatment consists of reduction and retention. *Reduction* is effected by a manipulation termed *taxis*, the patient being placed in a recumbent position, and the muscles of the abdomen relaxed; gentle and steady pressure is made by the hand in the direction of the descent. *Retention* is effected by continued and suitable pressure over the site of the protrusion, by means of a truss. The points of a good truss are, a well-made elastic spring and a pad, that can be accurately fitted. The spring is to be applied two inches below the crista of the ilium, and not above it, as is frequently done. Care must be taken to prevent excoriation, and also that every portion of intestine or omentum is removed from the sac previous to its application. By constant and careful use of a truss, a radical cure may be effected in a child, but rarely, in an adult.

IRREDUCIBLE HERNIA.

When the contents of the sac cannot be restored to the abdomen, the hernia is called irreducible. It may arise from adhesions between the sac and the intestine contained, or from membranous bands stretching across the sac; from great enlargement of the omentum or intestine, or contraction of the cavity of the abdomen. The patient usually suffers from flatulence, indigestion, and constipation, owing to the peristaltic movements of the bowels being partially interrupted.

The *treatment* consists in carefully regulating the bowels, avoiding any great exertions, and the wearing of a bag truss to support the tumour, and prevent further protrusion.

STRANGULATED HERNIA.

This is an incarceration of the contents of the sac, with inflammation and an interruption to the passage of fæces and the circulation in the part. The inflammation is caused by the constriction, which may be the result of spasm, or sudden enlargement of the intestine by fæces or gas.

The *symptoms* are flatulence, constipation, pain in the part and abdomen, nausea and vomiting; sometimes the matter is stercoraceous. The countenance is pale and anxious, the skin cold and clammy, and the pulse, which was at first full, now becomes rapid and indistinct; gangrene has taken place, the pain subsides in the tumour, which feels doughy and crepitant upon being handled. The vomiting may cease, and the patient will appear more comfortable, although he is actually sinking. It may be that the integuments and coverings of the intestine may inflame and slough with the intestine; and, after a copious feculent discharge, the patient may recover by artificial anus.

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When the tumour is small and recent, and the constriction tight, a few hours may produce death, if no relief is afforded; when the hernia is old and large, days may elapse.

Many of these symptoms may exist in other diseases, as in colic, or ileus, but inquiry or examination should always be made as to hernia.

Treatment. — The great object is to relieve the strangulation. In the first place taxis should be resorted to, and an effort made to reduce the contents of the sac. In order to facilitate this object, bleeding, warm bath, purgatives, enemata, opium, etherization and cold applications to the tumour will be found of use. A tobacco injection, made with ℨj to Oj of water, may be of use, but requires great caution in its use, on account of its prostrating effect. These remedies may so relax the system that the reduction can be effected; at any rate they will diminish the inflammation if judiciously used. If not successful, the knife must be used.

INGUINAL HERNIA (FIG. 245).

Bubonocele is a common name for this variety of hernia, which consists of a tumour in the groin, made by a descent of the gut or omentum through what are called the rings of the abdomen. These are the weak spots at which the protrusion takes place.

Before studying the operation for strangulated inguinal hernia, it will be proper to examine the anatomy of the parts in their natural condition, and then the varieties of the disease.

For *anatomy of inguinal hernia refer to Anatomy*, page 88.

Oblique, or *indirect* inguinal hernia, occurs thus: — The intestine, or omentum, first pressing against the parietal peritoneum, distends it and forms it into a sac; this sac, containing the intestine, then presses against the fascia transversalis at that portion where it is thin, and passes from the abdomen to the cord, which spot is called the internal abdominal ring, although it is not a hole. The sac, covered by the fascia transversalis, which is now thickened by pressure, then descends the inguinal canal, behind the transversalis and internal oblique muscles, and when it reaches the external ring it is covered by the cremaster, which may be considered as a continuation of these muscles; thus covered, it escapes at the external ring, and there receives an investment from the intercolumnar or external spermatic fascia, the superficial fascia and the skin. We thus see that the intestine is covered by a representation of all the structures forming the parietes of the abdomen.

Direct, or *ventro-inguinal hernia*, is a protrusion at the external abdominal ring, having its coverings formed in very much the same manner as the last, but instead of the cremaster muscle forming a covering, it is covered by the expanded tendon of the internal oblique and transversalis muscles. Sometimes this tendon is split, and there is no covering representing this portion of the parietes of the abdo-

men. The tumour in this variety is nearer the symphysis pubis, and is on the inner side of the epigastric artery, whereas, in the indirect variety, the tumour is on the outer side of the epigastric artery.

Concealed inguinal hernia is a term applied to a protrusion which has been detained in the inguinal canal.

The *operation* for relieving the stricture in an indirect inguinal hernia is to be performed by placing the patient upon the edge of a table, with each foot resting upon a chair; the surgeon sits before him, and makes an incision extending from the upper part of the tumour nearly to its base. The skin having been divided, the superficial fascia must next be divided. This will be found to exist in the form of laminæ, the most inferior of which is the thickest; having been, in the natural condition of the parts, that portion of the fascia which fills up the space between the columns of the external ring, and

Fig. 245.

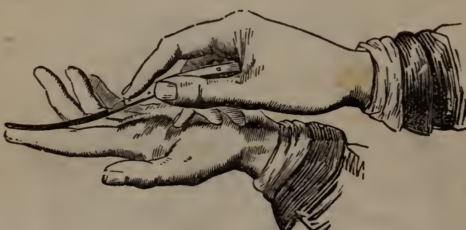
which is sometimes called the intercolumnar fascia. After this division the cremaster muscle will be exposed, altered from its natural appearance; the fibres being stretched and separated from each other, and being more pallid than natural. Having divided these fibres, the next covering will be the fascia transversalis, which is continued from the abdomen upon the cord; this being done the hernial sac is then exposed.

This sac being formed of peritoneum, has been mistaken by some for the intestine, from which it is to be distinguished by not having a flexure, or crease, which the intestine always has. The sac is to be opened carefully, pinching up a part and rubbing it between the fingers, in order that no portion of intestine may be included; a small opening is to be made, and into this a director may be introduced and the sac divided freely.

Bloody serum will escape freely, and the contents of the sac be thus

exposed; the convolution, or knuckle of intestine will vary in its colour, according to the period and intensity of its strangulation, between a light red and a deep chocolate colour; very often the intestine will exhibit patches upon its surface when the inflammation has been intense. The finger is then to be introduced to examine the point of stricture; if none should exist, an attempt at reduction should be made, if the intestine be in a proper condition. The stricture having been detected, a probe-pointed bistoury, with a cutting edge only near the end, is introduced flat upon the finger (Fig. 246), and a slight cut made directly upwards to the extent of one or two lines. The only danger to be apprehended is the wounding of the epigastric artery, and this is avoided by making a vertical, instead of a lateral incision. The sac may be strictured by the external or internal ring, or in the canal by the lower edge of the tranversalis muscle.

Fig. 246.



The stricture being relieved, the gut is to be returned, the edges of the wound are to be carefully approximated, and a compress applied to support the part, and prevent accidental reprotrusion. Instead of increasing the peristaltic motion of the bowels by laxatives, it is better to quiet them by anodynes. After cicatrization a truss must be worn to prevent a return of the protrusion, though occasionally the operation produces a radical cure. Such is the course of an ordinary case; but it may be found upon opening the sac, that the hernia is irreducible, owing to the intestine adhering to the sac; the stricture is to be relieved, and the wound dressed, and no attempt made to restore the intestine, unless the adhesion be recent or slight.

Should the intestine be extensively mortified, it is not to be returned, the only chance of life being through the establishment of an artificial anus; but if mortified only in a few spots, the spots are to be included with a fine ligature, and the intestine returned; the ligature finds its way into the interior of the gut, and is discharged with the fæces.

In case there should be a gangrenous condition of the omentum, the gangrenous part should be cut off, and the vessels secured by fine ligatures; the remainder may then be returned to the abdomen, or be al-

lowed to remain impacted in the outlet, and thus prevent future tendency to protrusion.

Some have successfully divided the stricture exteriorly to the sac, the sac being reduced with the hernia. The objection to this operation is the danger of there being a stricture within the sac; and if the gut should be gangrenous it will not be discovered.

Usually the cord will be found behind the sac, but sometimes it is split up, and its constituents found lying upon the sac; caution is then required to avoid wounding the artery and duct.

The operation for direct or ventro-inguinal hernia, is very much the same. There will be no cremasteric-covering, but in place of it an expansion of the conjoined tendon of the internal oblique and transversalis muscles; sometimes this is wanting, owing to the tendon having been split, especially if the protrusion is sudden, and the result of great violence.

In a concealed inguinal hernia, the tendon of the external oblique must be divided, as well as the lower portion of the internal oblique and transversalis muscles.

FEMORAL HERNIA (FIG. 247).

This is most common in women, owing to the natural form of the pelvis. The descent occurs at the *crural* ring; in order to understand which, it will be necessary to refer to the *anatomy of the part.* (See *Anatomy,* page 101.)

Fig. 247.

The tumour is more spheroidal usually than in inguinal hernia, and will be found to be beneath Poupart's ligament, instead of above. The fundus of the tumour is bent upon its neck, which curvature must be

attended to in producing taxis. Strangulation is more common and more severe than in inguinal hernia.

The operation for the relief of stricture is thus performed. The patient being properly placed upon a table, and the parts being shaved, the skin is pinched up and divided by transfixion, in order that there may be no injury to the important parts beneath. The wound of the skin may be crucial in shape, or resemble an inverted T.

After dividing the skin, the superficial fascia is exposed; this being divided, the fascia propria is brought in view; that fascia is sometimes much blended with the sheath of the vessels. Under the fascia propria will be found the hernial sac. It is opened in the same cautious manner as before, when a smaller quantity of fluid will escape than in inguinal hernia, and the convolution of intestine be readily recognised. The seat of stricture is then to be sought; it may be at Hey's ligament, at Gimbernat's ligament, or at the mouth of the sac. The stricture is to be divided with great care, for fear of an irregular origin of the obturator artery, the neck of the sac being surrounded by it.

The gut being returned, the after treatment will be the same as in inguinal hernia: the patient is to be kept in a recumbent position. Formerly, purgatives were administered after the operation, but now the opiate treatment is found more successful. Occasionally the patient is troubled with tympanites and flatulence, which will be relieved by a carminative, or enema of turpentine.

UMBILICAL HERNIA.

This is common in infants, in whom the umbilicus is not consolidated. It is produced by crying; and appears as a soft, compressible tumour.

It occurs also in women who have borne many children; though in them the point of the protrusion is not through the navel, but near it.

Strangulation does not often take place.

The *treatment* in a child is simple and effective. A small hemispherical pad, made of cork, or half of a nutmeg, covered with buckskin, is properly fitted, and there secured by a broad strip of adhesive plaster, which should surround the belly of the child.

In the *adult* the tumour may become very large, and usually contains a large quantity of omentum. Pain, indigestion, and constipation are often its accompaniments. The *treatment* consists of a large truss, adapted to the case. In case it should be strangulated, the operation for relief of the stricture is performed by making an incision through the skin and superficial fascia, which exposes the sac; this is to be opened in the usual manner. The incision for the relief of the stricture is to be made in the linea alba.

OTHER VARIETIES OF HERNIA.

SCROTAL HERNIA

Is a term applied to the protrusion of intestine when it has descended from the groin into the scrotum. It occasionally entirely obscures the penis, and reaches almost to the knees. Its coverings are those of inguinal hernia.

CONGENITAL HERNIA.

This depends upon a want of obliteration of the connexion between the peritoneum and tunica vaginalis of the testicle. The intestine descends in the same manner as the testicle. It has no sac or peritoneal covering other than that in which it and the testicle are contained.

This is most common in young male children, and is easily cured by a truss; there being a natural tendency to closure in this tubular connexion between the peritoneum and tunica vaginalis. Care should be taken in the application of the truss or compress, not to injure the spermatic cord.

In very young children a graduated compress and adhesive strips will effect a cure if properly applied.

VENTRAL HERNIA

Is a protrusion of the intestine at any part of the belly except the navel and groin; and it may be the result of a bruise, wounds, and unnatural weakness of the muscles of the abdomen.

VAGINAL HERNIA

Is a protrusion of the intestine into the vagina.

PERINEAL HERNIA.

When the tumour is in the perineum, having descended between the bladder and rectum.

PHRENIC, OR DIAPHRAGMATIC HERNIA

Is a protrusion through an opening of the diaphragm.

The intestine is sometimes strangulated within the cavity of the abdomen, through an opening in the mesentery, or meso-colon, or some portion of the peritoneum, or peritoneal band, resulting from inflammation.

DISEASES OF THE RECTUM.

FISTULA IN ANO (FIG. 248).

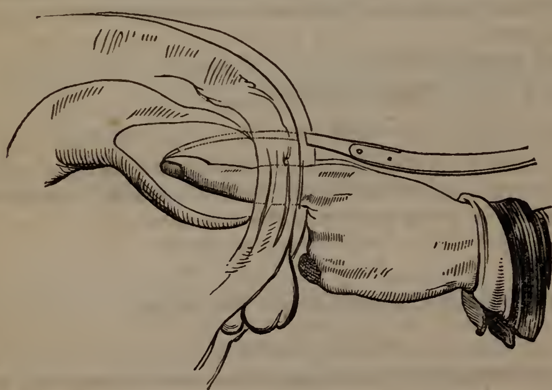
A *Fistula* is said to be *complete* when a sinus communicating with the bowel, opens upon the nates. When it does not communicate with the bowel, but opens externally, it is called a blind external fistula;

when it opens internally but not externally, it is called a blind internal fistula.

If complete, there is discharge of pus, fæces, and wind, and it is attended with heat, uneasiness, and pain. The sinus is sometimes very tortuous, and often multilocular. The internal orifice is usually about an inch and a half above the anus, but sometimes higher. The cause producing it may vary. It may originate in an inflammation of the rectum, or by an abscess external to it. It is very frequently connected with phthisis caused by the constant cough in that disease.

The *treatment* for complete fistula is generally that of the knife, the object being to place the part at rest, and convert the sinus into an open sore. The bowels having been entirely emptied, the index finger of one hand being oiled, is introduced into the rectum, and a probe-

Fig. 248.



pointed bistoury is introduced through the sinus into the gut, so that its probe touches the finger; thus kept in contact, both finger and bistoury are withdrawn, completely laying open the sinus, and dividing the sphincter ani muscle. Any bleeding vessel is to be tied; hemorrhage by oozing is to be stopped by stuffing with lint; a small portion of lint is to be placed between the lips of the wound, so as to prevent their closure; the object being to make the whole track inflame, granulate, and heal from the bottom. After the operation, a dose of morphia may be given to promote quietness and sleep; and after three or four days a dose of castor oil, which will bring away the contents of the bowel, and the dressings of the wound. Subsequently it will only be necessary to attend to cleanliness, and prevent the edges from uniting.

If the opening be very high in the rectum, it is better to use the

ligature in preference to the knife, on account of the danger of hemorrhage from the hemorrhoidal arteries. The ligature only is to be used in phthisical cases; it gradually cuts itself out, and leaves the part solid behind it. A blind fistula may be readily converted into a complete one by puncturing the intestine should it be an external fistula, or the skin in case it should be an internal one.

FISSURE OF THE ANUS.

This is an ulceration or cracking of the skin and mucous membrane, on the verge of the anus; and is attended with intense pain, especially upon going to stool. It results very often from dyspepsia, and this circumstance must materially affect the treatment. Alteratives and laxatives are necessary to bring the bowels into a healthy condition. The local applications are caustics and anodynes, such as nitrate of silver, which has a soothing as well as antiphlogistic power; opium, in the various forms of ointment, solution, and poultice Sometimes it is necessary to excise the part, or divide partially the sphincter ani muscle.

HEMORRHOIDS.

Piles, or hemorrhoids, are divided into external and internal. They are more common in males than in females, and rarely occur in children. The predisposing causes are whatever tends to determine the blood to the rectum, such as constipation, pregnancy, sedentary habits; and the exciting causes may be purging, diarrhœa, &c.

EXTERNAL PILES

Are a congeries of varicose veins, surrounded by condensed cellular tissue. In some cases, bleeding occurs from ulceration of the skin or mucous membrane covering them. When they do not bleed, they are said to be blind. When the blood has coagulated, they become hard. Usually, there is more than one.

The *palliative treatment* consists in the application of astringent and anodyne ointments, made of galls, opium, &c., and the regulation of the bowels with laxatives, such as sulphur, rye-mush with molasses, &c.

The *radical treatment* is removal by scissors or bistoury; arresting the hemorrhage, and producing a healthy ulcer. A recent tense, single pile, may be successfully cured sometimes by freely evacuating its contents by a lancet.

INTERNAL PILES

May be of the same nature as external ones, or of a sarcomatous character; but more frequently they consist of an abnormal development of the submucous cellular tissue, having the nature of erectile tissue; the tumour has a broad base, and its surface resembles a

strawberry; at stool they protrude, and are attended with hemorrhage. The general health will suffer by emaciation, indigestion, pain, and there may result fistula, prolapsus, and disease of the genital organs.

Treatment.—In the first place, the stomach and bowels must be regulated by laxatives;—disorder of the liver must also be corrected, since any obstruction of the portal circulation in that organ predisposes to hemorrhages, or congestion of all the chylopoietic viscera; there being no valves in the veins forming the portal vein. Great benefit will result from the use of astringent injections, such as solutions of zinc, oak bark, &c.; but the radical cure consists in the removal of them, by strangulating with a ligature or wire applied by means of a double canula.

Piles should not always be cured in elderly persons, especially those with tendency to diseases of the head.

PROLAPSUS ANI.

This is an eversion and protrusion of the rectum beyond the anus, and is dependent upon relaxation.

The extent of the protrusion varies much in different cases; in some instances being confined to a small portion of the mucous membrane; in others, the rectum, and perhaps a portion of the sigmoid flexure escape. In children, worms, diarrhœa, straining, and crying, may promote the disease. In old persons, it is brought on by enlarged prostate, stone, coughing, &c. When the gut habitually descends, the tumour is red and large.

The *treatment* consists in removing the cause; in regulating the bowels, and carefully replacing the intestine after each protrusion. The evacuations should be made in the recumbent position.

The general habit should be invigorated by tonics, and the tumour should be bathed with cold astringent washes. It may be necessary to lubricate the parts before reducing them, and afterwards a T bandage should be worn, to prevent the prolapse.

In extreme cases, operations have been performed. A fold of the mucous membrane has been removed, in order to contract the intestine; and a portion of the sphincter has been cut out, in order to diminish the orifice of the anus.

ENCYSTED RECTUM.

This consists of an enlarged and diseased condition of the sacs of the mucous membrane of the rectum, just above the anus.

The treatment consists in drawing down the sacs with a bent probe, and excising them with a pair of scissors.

IMPERFORATE ANUS.

This is a congenital imperfection. The rectum terminates in a cul de sac, at various distances from the ordinary location of the anus; in

some instances it is so near the skin as to form a prominence, by the constant collection of fæces. In such cases, the operation is easy and simple: a free opening being made in the proper direction, with regard to the bladder or vagina, the meconium escapes, and the edges are prevented from uniting, by the interposition of a piece of lint. In other instances, it is impossible to reach the cul de sac; then it is necessary to form an artificial anus. This is done by opening the descending colon immediately under the left kidney, making the incision through the skin and fascia, so as to expose the posterior portion of the bowel, which is not covered by peritoneum at this part; a sphincter is said to be formed in the loins, though it is necessary to wear a pad.

URINARY CALCULUS.

Calculi are generally formed in the kidneys by a precipitation of earthy substance, and when they pass freely and frequently, the disease is termed *gravel;* when they are retained and become large, the disease is called *stone.*

The symptoms of stone in the kidneys are pain in the loins, irritation and retraction of the testicle, bloody urine, and inflammation of the kidney. The passage of the stone through the ureter causes most acute and severe pain in the loins and groin, faintness, and sickness of stomach, which may last for several days, and is only relieved by the stone entering the bladder.

The treatment for a *fit of the gravel*, as these attacks are called, consists in bleeding, warm-bath, large doses of opium, soothing enemata, diluent and diuretic drinks, spirits of turpentine, &c. The ordinary result is the passage of the calculus; but sometimes it is retained in the kidney, increasing in size, and assuming the branching form of the pelvis, calices, and infundibula. It does not always produce inconvenience, but generally is attended with wasting of the organ, or suppuration, the abscess bursting into the colon or loins.

A small calculus, lodging in the bladder, and not being discharged through the urethra, serves as a nucleus for further deposit; any foreign body, such as a needle, drop of blood, or bullet, may serve, also, as a nucleus. The symptoms of stone in the bladder are, frequent, sudden, irresistible, unrelieved desire to make water; pain in the glans penis, and elongation of the prepuce; sudden stoppage of the stream in urination, and its re-establishment by change of position—the urine being mixed with mucus and sometimes with blood; but nothing but a sound can positively prove its existence. Many of the symptoms are simulated by other diseases, such as stricture of the urethra, enlarged prostate, irritable bladder, &c. The rectum sympathizes, especially in children, and hemorrhoids or prolapsus ani are apt to occur. Stones vary in their form, size, color, consistence, and chemical composition; some are rough on their surface, others smooth; they are more frequently of an oval shape. The size may be that of a

pea, or that of a goose-egg. The most common color is a light brown; some, however, are nearly white, others nearly black. Some are soft and friable, and crumble easily; others are flinty, and require great force to fracture them.

They are most generally composed of lithic or uric acid, lithate of ammonia, phosphate of lime and magnesia, oxalate of lime, and carbonate of lime. The lithic acid stones are perhaps the most common: they are oval, flattened, of a fawn-colour, and consist of concentric laminæ; the phosphatic stones are high-coloured and friable. The oxalate of lime forms the mulberry calculus, which is the hardest stone, of a very dark colour and a very rough surface. The number existing in the bladder at once, may vary from one to several hundred.

The formation of stone is consequent upon a derangement of health, deficiency of exercise, indulgence in animal food, defective condition of the skin, and dyspepsia. It is also dependent upon climate, age, locality, and hereditary influences. The immediate cause in every case cannot be discovered; some suppose that the character of the water drank influences its production. Stones are sometimes encysted in the prostate gland and urethra.

Treatment.—Gravel may be prevented or mitigated by attention to the skin and digestion, the use of acids or alkalies, dependent upon the diathesis of the patient manifesting the disease; but, after the *stone* has been lodged in the bladder, it cannot be removed by medicines: surgical means must be resorted to.

Sounding.—This requires great tact and care in its performance, and must only be attempted when the condition of the patient is most favourable; if performed immediataly after a journey, or during a fit of the gravel, the consequences might be serious. A sound is a solid steel instrument, resembling a catheter in shape, but having its curvature much nearer the extremity, and a broad flattened handle. The patient should be placed in a recumbent position, and the urine retained in the bladder for some time previous to sounding. The instrument being carefully introduced, can be moved about in the bladder, and when the stone is touched, a distinct click will be heard, and a sensible impression of impingement will be felt. There are many sources of error in sounding: the instrument may pass over the stone, when lodged in the inferior fundus of the bladder, or the stone may be small and encysted in the mucous coat; on the other hand, we may be deceived by the sound grating against a diseased prostate or sandy matter in the urethra. In case of difficulty in detecting a stone, it is better to repeat the operation frequently, the patient being placed in different postures, than to prolong the exploration, at the risk of producing inflammation of the bladder. Having detected the stone, it is possible to form some idea of the size and number by sounding. Some have attempted the disintegration of the stone by injecting various solutions into the bladder; but the most common operations are Lithotomy, Lithotrity, and Lithotripsy.

LITHOTOMY.

This is an ancient operation, modified and improved in modern times. It is to be performed in children and in old persons, when the stone consists of the oxalate of lime, and when there is stricture, or diseased prostate.

The different modes of performing the operation are the lateral, high, and bilateral. The lateral is most common, and is performed in this manner.

The patient, having been properly prepared by emptying the bowel and retaining the urine in the bladder, is placed upon a table of convenient height, and firmly bandaged hand to foot, with his knees elevated. A staff as large as the urethra will admit, and deeply grooved on the convex and left side, is then introduced. Two assistants separate the knees, so as to expose the perineum, which ought to be cleanly shaved. The patient is then to be brought to the edge of the table, and the surgeon seats himself in front with his instruments in good order, and conveniently at hand. The staff, being brought in contact with the stone, is well hooked up under the symphysis pubis, and not pressed down upon the rectum, and then given to a third assistant, who is directed to hold it vertically, and also charged with keeping the scrotum out of the way.

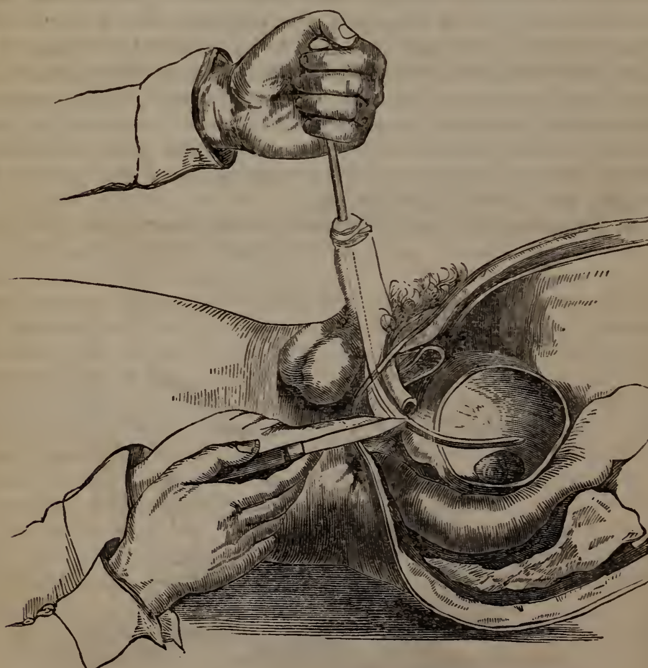
An incision with a scalpel is made, about three inches long, com-

Fig. 249.

mencing about one inch behind the scrotum, and extending downwards and outwards to a point between the anus and tuberosity of the ischium, and even beyond it. Various measurements are given by different surgeons as to the point at which this is to be commenced. No well-informed surgeon should depend upon an absolute measurement, on account of the difference which exists in different patients,

with reference to the size and depth of the perineum. He should inform himself of the probable size of the prostate gland by an examination per anum, and then, by his anatomical knowledge, make his incision so as to expose the membranous portion of the urethra, taking care not to cut the bulb of the corpus spongiosum in front and the rectum behind. Having cut through the skin and superficial fascia of the perineum, which is very thick, especially in fat persons, the transversus perinei muscle, the transversus perinei artery, the lower edge of the triangular ligament, and it may be a few fibres of the levator ani muscle, must then be divided. By an examination with the fin-

Fig. 250.



ger, the staff may now be felt in the urethra. By means of the finger and nail this space should be increased, and the urethra opened by a bistoury, which will be indicated by a flow of urine. The gorget should now be introduced into the wound, with its beak securely fixed in the groove; it is then pushed in the direction of the bladder, cutting through its neck and prostate gland. Care must be taken to depress the handle of the gorget whilst making this thrust, for fear of wound-

ing the rectum. Urine gushes out, the gorget is carefully removed, for fear of wounding the internal pudic artery, and the finger introduced into the bladder to discover the stone, its position, and size. A strong pair of forceps are then introduced, and the stone grasped in such a way that its short diameter shall engage in the wound, whence it is to be delivered slowly and gradually.

If it be impossible to remove the stone through this opening, it may be enlarged with care, on the same, or, if necessary, the other side. After its removal, the finger must again be introduced, to see if there is another stone.

The bladder being freed from all calculus by the forceps or syringe, a tube is introduced into the bladder through the wound, by which the urine is to escape. The patient is then put to bed, with the knees placed together. A small cup or saucer receives the urine from the tube. Severe hemorrhage may result from a wound of the bulb of the corpus spongiosum, or from cutting the urethro-bulbar artery. If a ligature cannot be applied, it must be compressed by the finger as long as may be necessary.

There may also be a venous or arterial oozing, which is to be arrested by removing the tube and cramming the wound with lint, a catheter being introduced through the urethra. Should there be no hemorrhage, the tube is to remain until the wound has granulated around it, and the urine has commenced to flow from the urethra.

Some prefer to open the bladder with a scalpel, having confidence in their anatomical knowledge, and considering the gorget as a clumsy instrument, a remnant of olden times. Others use a concealed bistoury, cutting either upon one or both sides of the urethra. Besides which are various instruments, modifications of the gorget, and scalpels with beaks attached.

In four or five weeks the wound is healed.

The *high operation* is performed by making an incision through the linea alba, opening the bladder where it is not covered by peritoneum. This is only necessary where the stone is of enormous size, the prostate diseased, or the space between the tuberosities of the ischia contracted.

Stone in women, is much less frequent than in men, because the renal calculus is more readily passed by the urethra. Should it be retained, and increase in size, it may be removed by dilating the urethra sufficiently, or by the lateral operation, making the incision from the orifice of the urethra, and through the neck of the bladder. Incontinence of urine is apt to follow.

The *recto-vesical* operation consists in cutting into the bladder from the rectum.

LITHOTRITY.

Lithotrity signifies the boring or drilling the stone, and has been most successfully accomplished by Civiale. His instrument consists

of a straight canula containing a drill and three claws which can be protruded after its introduction into the bladder. These claws are equally liable to catch the coats of the bladder as well as the stone, and the operation has been superseded by the following.

LITHOTRIPSY.

This implies the *crushing* of the stone whilst in the bladder; and it is preferred to all other operations for disintegration.

The cases most favourable for this operation are adults, where the urethra is free from stricture, the bladder free from irritability and not contracted, and the prostate not enlarged. A mulberry calculus would be unfavourable for lithotripsy, on account of its hard character.

The instrument most frequently used is Heurteloup's (Fig. 251), or a modification of it. It consists of two blades, which slide one upon

Fig. 251.

the other, the extremities being slightly bent. It can be introduced into the bladder as a sound or catheter, and afterwards the blades are separated, to grasp the stone. In the original instrument the male blade was struck with a hammer, and thus the stone was broken; now the crushing power is that of a screw, variously adapted,—that of Mr. Weiss being most simple and perfect.

The extremities of the instrument have teeth (Fig. 252) to retain the stone when grasped, and also fenestræ to allow of the escape of sand or powdered stone.

Fig. 252.

The patient must be previously prepared for the operation, by regulation of the general health, dilatation of the urethra, and distension of the bladder. The patient lies on a convenient table or bed, with the pelvis elevated, so as to throw the stone into the fundus of the bladder; the bladder must be full, so as to prevent its coats from being entangled

in the instrument. If urine cannot be retained, tepid water must be injected. The instrument must be oiled and warm.

After encountering the stone and fairly grasping it, an operation which requires tact in manipulation, the stone is crushed by slowly and gradually turning the screw. Then the instrument should be withdrawn, and when the irritation has subsided, subsequently introduced to crush the fragments. Thus many operations may be required to reduce the stone into fragments sufficiently small to pass the urethra.

It is not to be expected that fragments will escape at the first urination: the after treatment should consist of diluent drinks, and bland injections to accelerate their passage; and it may be that the hip-bath, anodyne enemata, and leeches, will be required. The sources of danger are the irritability of the bladder, and urethra; inflammation often resulting from the irregularity of the fragments, and too frequent introduction of the instrument. Sometimes fragments are arrested in their passage through the urethra: a bougie or catheter should be introduced, of large size, and the fragment pushed back into the bladder: should it become impacted, it may require a special instrument for its extraction, or an incision in the perineum.

Jacobson's instrument is used by many. Its extremities are connected by a link: thus a loop is formed to grasp the stone when the blades are separated in the bladder. By the operation of the screw, the female blade is pulled upon the male; whereas in Heurteloup's the male is pushed upon the female, — thus in the latter there is less danger of fine fragments or sand being caught between the blades, which would impede the movement.

VENEREAL DISEASE.

The history of this disease is involved in some obscurity, although it is generally believed to have existed from the earliest ages. It consists of *Gonorrhœa* and *Syphilis*, which are usually considered as dis tinct diseases, although there are high authorities to the contrary.

GONORRHŒA.

Gonorrhœa is an acute inflammation of the lining membrane of the urethra, commencing in its anterior portion. It is caused by matter from another, during sexual intercourse. In about five days a discharge appears, although it may occur in a few hours, or not until ten days after coition.

Symptoms. — Heat, itching, redness of the glans, and swelling of the orifice of the urethra; the stream of urine is small and attended with burning and smarting; the swelling, redness, and pain increase; the discharge is no longer limpid, but turbid, puriform, and profuse, sometimes being mixed with blood; the thighs, loins, testicles, and

groins sympathize in a dull pain, and there may be fever. Chordee may occur, which is an intensely painful erection of the penis, which is bent like a bow, with the convexity upwards: this is owing to the corpus spongiosum being filled with lymph, which prevents its expansion by blood. It is aggravated by the warmth of the bed, and voluptuous dreams.

The glans may become excoriated; the prepuce œdematous, inducing phymosis; a sympathetic bubo may form in the groin, or an abscess in the perineum.

The joints may be painful as in rheumatism; the testicle swell and inflame, constituting orchitis, especially if the patient is imprudent in exercise, during which the discharge diminishes. As the orchitis declines, the discharge reappears.

Gonorrhœa is capable of self-cure; the symptoms gradually subsiding, and the discharge diminishing, and becoming mucous in its character: it is then a *gleet*, which is without pain, redness, &c., but which is readily rekindled into an inflammatory gonorrhœa by imprudence in diet or exercise.

Treatment.—In the earliest stage, the ectrotic or abortive plan has been highly recommended, if the discharge has not reached the suppurative crisis. A strong solution of nitrate of silver, used properly with a glass syringe, may cut short the disease at the outset. It should be used but once or twice, and acts by neutralizing the virus, as an antiphlogistic, and also coats the urethra with a film which protects the villous surface This treatment generally fails, especially in irritable temperaments, and when not used in the earliest stage; and if not succeeding, is followed by an aggravation of symptoms.

In the *treatment* of gonorrhœa, it is to be remembered that the first attack is generally the most severe; hence the importance of *rest*, which is seldom complied with. Low diet, purging, and tartar emetic as an antiphlogistic and antaphrodisiac, together with the free administration of the super-tartrate of potash and nitrate of potash, are the most reliable remedies. Opium and camphor are also useful at night, in preventing painful erections and chordee, and a warm bath is most serviceable. Mucilaginous drinks may mitigate the ardor urinæ. Leeches and ice to the perineum are sometimes very advantageous.

The discharge now must not be suddenly arrested, else by metastasis the testicle, bladder, or prostate become involved. Strong injections are very injurious, although they may temporarily arrest the discharge. As the inflammatory symptoms subside, weak astringent injections may be used with a glass syringe: sulphate of copper, zinc, alum, or iron, in the proportion of half a grain to the ounce of water.

Cubebs and *copaiba* are remedies which seem to exert a specific influence on the urethra: the latter may be given in almost all stages of the disease; but the former should be restricted in its administration to the latter stage. These medicines often do harm, when persevered in too long, by inducing a chronic disease of the bladder,

attended by a slight discharge. In the chronic stage of the disease, the discharge may be benefited by weak solutions of nitrate of silver, and a weak solution of chloride of zinc. In a gleet, a large bougie introduced into the urethra, will often prove of immediate service.

Spurious gonorrhœa, or balanitis, is a discharge from the prepuce and glans, often induced by want of cleanliness, or gonorrhœal matter. A solution of nitrate of silver, and frequent application of cold water will cure it.

Warts are to be removed by the scissors or knife, and their bases touched with nitrate of silver, or nitric acid.

Women suffer less than men, although the vagina is involved as well as the urethra. The symptoms are the discharge, swelling, pain in micturition, sitting, and walking, aching in the back and loins.

The treatment is upon the same principles as in men; stronger injections may be used without the danger of stricture; and lint saturated with medicated solutions, retained in the vagina. Young girls suffer from spurious gonorrhœa and leucorrhœa, from which they are to be carefully distinguished. Leucorrhœa is chronic in its character from the first, attended with lassitude, pain in the back, pallor, irregular menstruation, and the urethra is not involved generally.

SYPHILIS.

This term comprises all diseases resulting from a certain virus.

Primary Symptoms.—After one or two days' incubation of the virus, the pustule forms, and the ulcer is established at the sixth day. It is first attended with redness, itching, and heat; then a vesicle appears, becomes purulent, breaks, and an ulcer is formed. This is circular or oval, excavated, and pale, with a bright red areola; the discharge is thin, ichorous, and infectious; finally, flabby granulations and cicatrization. If the virus touches an abrasion, the sore may appear at once. This sore is not to be mistaken for a common ulcer, or abrasion, or herpes. Most frequently it is situated on the collum behind the corona; the most unfavourable position is the frænum, which it often destroys.

Treatment.—If the ulcer is freely cauterized before the sixth day, the poison is destroyed, the ulcer converted into a simple one, and the system is uncontaminated. After the application of nitrate of silver, water may be used, or water medicated with aromatic wine, or chloride of soda: granulation and cicatrization are treated as in any other case, and thus a simple venereal ulcer heals.

HUNTERIAN OR TRUE CHANCRE.

The sore is circular, much excavated, with hardened base and edges; and the surface is of a tawny or brownish hue, covered by a thin pellicle. It occurs most frequently on the glans penis or the skin, and is usually solitary, and has no areola.

It is to be *treated* by the application of lunar caustic, and the inter-

nal administration of mercury and iodide of potash. Mercury hastens the cure of the primary sore, and affords security against secondary consequences, especially of the Hunterian chancre; some general constitutional treatment may also be necessary. Blue pill may be given every night and morning, until the gums are slightly sore, and there is a slight increase of saliva: its action should be maintained at this point for several weeks.

PHAGEDENIC CHANCRE.

This is rapid in its progress and painful; the surface yellow, and dotted with red streaks; the shape irregular; edges ragged and undermined; their discharge is thin, profuse, and sanious. These ulcers eat deeply into the skin of the penis and surrounding parts. This chancre is apt to occur in those whose constitution is broken down with drink, debauchery, prostitution, and mercury; mercury usually aggravates it.

Treatment.—As a local application, the nitrate of mercury is most beneficial; the chloride of zinc is also calculated to arrest the spread of the disease. The constitution must be supported with tonics, stimulants, and good diet.

BUBO.

Bubo is an inflamed lymphatic vessel or gland leading from a venereal ulcer; the glands may inflame from a wound of the foot or from gonorrhœa, but a real syphilitic bubo is the result of absorbed virus. Buboes vary in the rapidity of their development, and some are termed acute, others chronic; the former hastening to suppuration, whilst the latter are indolent. If one gland only is affected, and that above Poupart's ligament, and it rapidly suppurates, it is most probably caused by a non-indurated chancre, if one exist; but if many glands are involved, and they are deep-seated, the cause has been an indurated chancre.

Treatment.—An acute bubo will often yield to rest, leeches, fomentations, &c., but if the venereal virus shall have created pus in the interior, leeches and cold applications will rather retard the cure. Poultices, and early evacuations, are then most to be relied on. Extensive collections of pus, and sinuses, are often the result of delay in eliminating the virus. The opening of a bubo at an early stage with a sharp lancet, even should no pus exist within, empties the congested vessels, and rather promotes a cure. Blisters and iodide of potassium will be found of use in assisting in absorption. In an indolent bubo an alterative course of mercury, and good diet are necessary.

Constitutional Symptoms.—These are secondary and tertiary.

The *secondary* symptoms speedily follow the primary, usually during the second month; consisting chiefly of general eruption, affection of the throat, fever, change of complexion, dryness of hair, rheumatic pains in shoulder and knee, headache. Different kinds of eruption

follow different kinds of primary sore, although there may be irregularity in this respect. Secondary symptoms are transmissible from mother to child.

Treatment.—The object is to assist nature in the elimination of the poison; hence we should not suppress the eruption, but act on the skin, kidneys, bowels, and other organs of excretion. The throat should be fomented, and touched with nitrate of silver. Mercury is not to be used if possible, especially in scrofulous weak temperaments, or when the constitution is broken by dissipation, or the previous abuse of mercury. Small doses of corrosive sublimate, or the protiodide of mercury, is the best form of administration. The iodide of potash is the most effective remedy in this disease. It is given in doses of 4 or 5 grains three times a day. Baths are most important; sometimes their value is increased by medicating them. Sulphur, and weak solutions of mercury, seem to exercise the best influence upon the local affections of the skin.

Tertiary Symptoms.—These seldom occur, except after the worse kinds of sore, unless mercury has been rashly used. The periosteum and bones are affected by a chronic inflammatory process. Suppuration, caries, and necrosis result; also, stiff joints, tubercular formations of the skin, and condylomatous tumours. Destruction of the gums, cheeks, deafness, syphilitic sarcocele, and iritis, are also among the consequences. These symptoms are not transmissible.

Treatment. — More dependence is to be placed upon the iodide of potassium, than any single remedy. The general remedies will consist of bathing, regimen, and alteratives. Opium and blisters are necessary to relieve the pain in the bones at night.

DISEASES OF THE URINO-GENITAL ORGANS.

STRICTURE OF THE URETHRA.

SPASMODIC STRICTURE

Depends on spasm of the muscles of the perineum, or upon contraction of the muscular portion of the urethra. It generally occurs in persons with some permanent obstruction. Exposure to cold, and indulgence in drink also favour an attack, which usually occurs after dinner. Cantharides absorbed from blisters produces the effect.

Symptoms.—Sudden retention of urine; great straining and desire to urinate; the bladder becomes distended, the countenance anxious, the pulse quick, the skin hot; at last the urine dribbles or the bladder may burst, and extravasate into the peritoneum, or perineum.

INFLAMMATORY STRICTURE.

This is another variety of the above, generally caused by abuse of injections, exposure, or intemperance during acute gonorrhœa.

Treatment. —A catheter should be introduced at once. This is

managed by introducing as large an instrument as the parts will admit of, and stretching the penis forward on the catheter, whose point at the same time should be directed towards the upper surface of the urethra, and pressed steadily but gently against any obstruction. Relaxation of the spasm may also be produced by bleeding, warm bath, Dover's powder, laudanum enemata, and cold water upon the genitals. Should all these means fail, and life be endangered, the bladder should be punctured from the rectum, or opened by a perineal section.

PERMANENT STRICTURE.

This is a contraction from permanent inflammation, plastic deposit having taken place in the submucous cellular tissue. The *occasion* of this inflammation may be clap, venery, kicks or blows, riding on horse-back, acrid urine, drinkings, &c. The most frequent *sites* are at the commencement of the membranous portion of the urethra, and also within a few inches of the glans penis. The *extent* and *degree* of contraction vary: sometimes the stricture is very tight, but limited, as if a thread had been tied around the urethra; more frequently it is of greater extent, continuing from a quarter of an inch to several inches. Several strictures may exist at once. Behind the stricture the urethra is enlarged, and serves to catch a calculus.

Symptoms.—These come on gradually: middle-aged men are most liable. Urination is frequent, tedious, and painful: the stream is thin, twisted, or forked. After urination a few drops pass which had collected behind the stricture. Pain in the perineum, thighs, and loins; erection is often painful: semen does not escape in coition, but passes into the bladder, and afterwards is voided with the urine; chill and fever constantly occurring, as in ague: a slight discharge is visible at the end of the penis upon rising in the morning; the testicles, rectum, and bowels sympathize, and the general health fails.

Treatment. — 1st. *Dilatation* by bougies of flexible metal, silver, or gum elastic, of sufficient size, since small bougies are more apt to be entangled than large ones. The natural structures are not to be mistaken for strictures, viz., an enlarged lacuna in the fossa; spasmodic contraction of the accelerator urinæ muscle; the triangular ligament, and prostate gland. The operation must be frequent and cautious until the cure is complete, and even afterwards, to prevent return of this disease, which is not uncommon; indeed, there is no certainty that it will not return. 2d. *Caustic* applied firmly to the stricture; it destroys irritability, but is more advantageous in stricture near the glans than the bladder. 3d. *Puncturation*, by means of a lanced stilet, introduced concealed in a silver canula; after the division, a catheter is to be introduced. 4th. *Opening the urethra* through the perineum, resembling a lithotomy operation; a catheter is then introduced into the bladder, and the wound heals over it.

FISTULA IN PERINÆO.

This is usually the result of abscess of the perineum, or a wound. The patient has rigors, fever, and an exquisitely painful prominence in the perineum, which opens and discharges, much to the relief of the sufferer. The opening, however, often remains, and through it the urine dribbles. This abscess may be caused by a kick, or urinous infiltration from an internal fistula, produced by a stricture.

Treatment.—This should be directed to the cause; if a stricture exist, this should be cured first, and then the fistula, by caustic application, the application of a red-hot wire, or by paring the edges.

ENLARGED PROSTATE.

The gland is enlarged, from chronic inflammation, brought on by gleet, stricture, horse exercise, &c.; it is most common in advanced life, and disappears upon the removal of the cause. Leeches, rest, counter-irritation, iodide of potash, laxatives, and enemata, are the proper treatment. But the gland is also enlarged in old persons,—a hypertrophy independent of inflammation. This enlargement takes place first in the middle lobe, and the lateral lobes enlarge unequally. The bladder sympathizes, and becomes irritable; the urine is fœtid, mucous, and its stains are often retained. Catheterism, opiates, laxatives, and regimen are the palliatives.

INFLAMMATION OF THE BLADDER.

This is usually a secondary affection, frequently resulting from gonorrhœa, &c. There is pain in the perineum and sacrum; micturition is frequent, with straining; the urine is mixed with mucus or pus.

Treatment.—Bleeding, leeches, hip-bath, opiate enemata, castor oil, &c.

Chronic Inflammation. Catarrhus Vesicæ.—May result from the same causes as the acute form; and also from over-distension of the bladder: it is attended with great irritability and incontinence of urine. The irritability and incontinence are sometimes the most prominent symptoms; and for them the injection of a solution of sulphate of morphia, or nitrate of silver will be found most serviceable.

ORCHITIS.

Swelled Testicle is a common accompaniment of mumps. It is often the result of an injury; but, oftener, of gonorrhœa and its treatment: exercise, wet, and cold, often induce it. Sometimes it is termed *hernia humoralis.*

Symptoms.—There is a great sense of weight, and the swelling constantly increases; the skin becomes tense, red, and glistening; the pain is intense, often producing fever and vomiting. The cord is often

swollen and painful. The epididymis is chiefly affected. The urethral discharge diminishes.

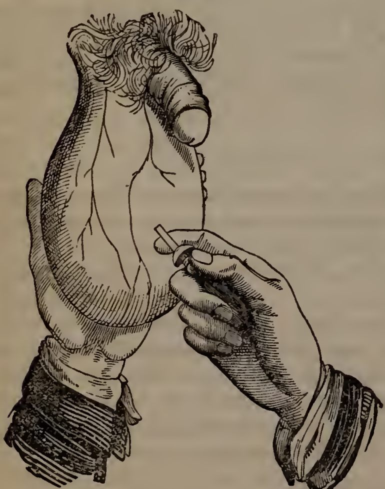
Treatment.—Bleeding, in a plethoric habit; leeches, purgatives, tartar emetic, and opium; cold or warm lotions, according to the patient's feelings. Low diet and the recumbent position are essential. The weight of the tumour must be sustained by a suspensory or handkerchief. After the acute symptoms have subsided, friction with mercurial ointment, astringent lotions, and compression by adhesive straps, will be useful. In discussing the hardness and swelling which generally remain, the iodide of potassium has the best effect. Abscess may result, but it oftener results from chronic inflammation or sarcocele.

Neuralgia of testes causes such severe pain that patients frequently apply to be castrated. The cause should be ascertained before treatment is commenced.

HYDROCELE (FIG. 253).

This is a collection of serum in the tunica vaginalis testis; commencing at the lower part of the scrotum, and gradually ascending. It is smooth on its surface, fluctuating. The testicle is situated at the posterior part of the sac, near the middle. It is to be distinguished from hernia by its transparency and progress: there is no impulse upon coughing: it does not retire by recumbency.

Fig. 253.



Treatment.—The *palliative* treatment consists of evacuation of the serum by a trocar. The *radical* cure is performed by injecting stimulating fluids, such as port wine and water, or solutions of zinc and iodine into the sac; or by introducing a seton.

CIRSOCELE.

Varicocele or cirsocele is a varicose condition of the veins of the cord. Some restrict the term varicocele to the enlargement of the veins of the scrotum. The *causes* are such as to produce obstruction to the return of blood; constipation, corpulence, tight belts around the abdomen, and warm climate. The left side is more frequently affected than the right, because the left spermatic vein is more likely to be

compressed by fæces in the sigmoid flexure, and because it is longer and not so direct in its course. The swelling is pyriform, and feels like a bunch of earth-worms.

Treatment.—The disease may be palliated or cured by removing the causes, bathing the testicle in cold water constantly, and supporting it with a suspensory. The radical cure often requires an operation for obliteration of the veins,—such as the actual cautery, compression by sutures, wires, springs, &c. The scrotum may be diminished with advantage.

ANEURISM (Fig. 254).

An aneurism is a pulsating sac, filled with blood, which communicates with an artery.

A TRUE ANEURISM

Is the result of disease, and the sac consists of one or more of the coats of the artery. The artery may be dilated, all the coats being entire, as is usually the case in the aorta; or, the internal and middle coats may be ruptured, and the sac is formed of the external coat. The interior of the sac is lined by fibrin in a membranous form.

FALSE ANEURISM

Is owing to a complete division of the arterial coats, either from a wound or external ulceration; the sac is formed in the cellular tissue.

DISSECTING ANEURISM

Is a sac formed by the infiltration of blood between the coats of an artery. This sac may communicate with an artery at several points.

CIRCUMSCRIBED AND DIFFUSED ANEURISM

Are terms used to signify its limits; whether confined to a cyst, or extending by infiltration into the surrounding tissues.

Symptoms.—The most frequent form of aneurism is the *true circumscribed aneurism.* The tumour, at first, is small, gradually increasing, soft, and quite compressible, being only filled with fluid blood. It has a distinct pulsation from the beginning, synchronous with the heart's impulse, increased by pressure on the distal side, and diminished or arrested by pressure on the cardiac side. A peculiar thrill is imparted to the hand, which can be heard by application of the ear. At first the pain is slight, and merely owing to interference from the adjoining textures. By pressure upon the nerves a numbness is produced; pressure on the veins and lymphatics causes œdema, discoloration, and swelling. The strength of the part is much impaired, as the tumour enlarges; the circulation in the extremity is weaker; the diminished volume of the main artery is compensated by enlargement of the side channels, the collateral circulation conveying the blood from the cardiac to the distal side of the tumour. The tumour

gradually becomes larger by the separation of fibrin, is less compressible, and pulsates less distinctly. The clot thus filling up the sac, restrains its further dilatation by the force of the heart. Ultimately, it may become smaller by continued absorption.

During the progress of an aneurism, adjacent parts are displaced, altered, and absorbed, even bone is rendered carious and absorbed by the constant pressure of the tumour. As the tumour enlarges, pain and numbness increase, and the general health fails. At length, the tumour may burst, opening upon the skin or some important cavity, and prove fatal, either by hemorrhage, or by pressure on important parts,—as the trachea, œsophagus, &c., or by suppuration and hectic.

The diagnosis from abscesses, glands, and solid tumours is important. An aneurism is soft and compressible from the first, and then becomes hard, whereas an abscess begins with induration and ends with softening. A tumour or other swelling, receiving an impulse from lying over the track of an artery, will no longer pulsate when raised or held to one side. An aneurism expands coincidently with pulsation; a solid tumour will not alter its volume by pressure either upon the distal or cardiac side.

Causes.—The disease is more frequent in men than in women, and seldom occurs before puberty; the *predisposing* cause may be said to be disease of the coats of the arteries; the *exciting* causes are muscular exertion, mental emotion, and intemperance.

Cure.—This may either be spontaneous or surgical — the spontaneous being owing to pressure on the cardiac side of the tumour, occlusion of the aperture of communication, coagulation and absorption, or by inflammation from sloughing of the cyst; this, however, is oftener the cause of death than a means of cure. Medical treatment may mitigate the symptoms, such as bleeding, rigid diet, horizontal position, and cold and astringent applications.

The *treatment* of aneurism by compression has been revived with great success in Dublin.

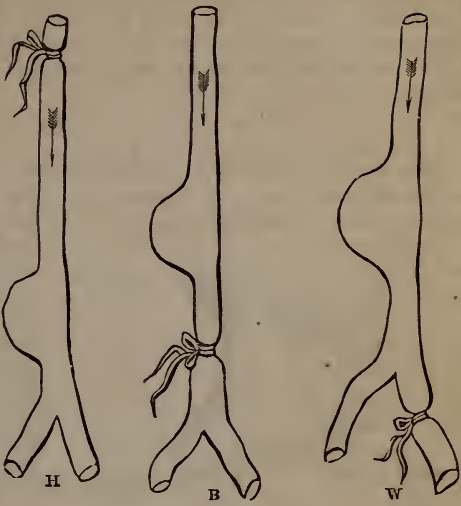
The *ligature* is generally relied on. Previous to the time of Hunter, the vessel was tied immediately above the tumour, and the sac opened. Hunter tied the artery at a distance from the sac (Fig. 254, H), in a healthy part, allowing the sac and its contents to be absorbed; *this* is the present mode of operating. Abernethy applied two ligatures, and divided the artery between them. Brasdor's operation (B) is directly the opposite to Hunter's, tying the artery immediately beyond the tumour. Wardrop modified this (W), tying the artery beyond the tumour and beyond its first bifurcation. The effect of a ligature is to arrest the blood and divide the internal and middle coats; a coagulum or plug is formed up to the first branch, and lymph is effused from the cut edges of these coats, and also surrounds the ligature upon the exterior of the artery. The lymph in the artery above the ligature firmly consolidates the internal and middle coats; and the cellular coat being compressed by the ligature is subsequently destroyed, and thus the ligature is removed with its noose entire; finally

the portion of the artery which had been included in the ligature will be found converted into a small cord.

The ligature should be round and small, or the coats will not be divided; inclusion of cellular tissue or a nerve will also prevent this division.

Secondary hemorrhage may result from the application of an improper ligature, or its premature removal, and also from the artery being too much exposed, or in a diseased condition.

Fig. 254.



ANEURISM OF THE AORTA.

The *arch* of the aorta is especially liable to aneurism, producing difficulty of breathing, pain in the chest, and palpitation of the heart, difficulty of swallowing, and troublesome cough, owing to its pressure upon the trachea, which is sometimes perforated; it should not be mistaken for an enlargement of the bronchial glands, or collections of serum or pus.

Aneurism of the abdominal aorta is usually situated just below the diaphragm, producing pressure on the thoracic duct, also caries of the vertebra, dropsy, and by its rupture, death.

Astley Cooper, James, and Murray have tied it without success; it should be treated only by medical means.

ANEURISM OF THE CAROTID.

This occurs most frequently in labouring people; it is situated at the angle of the jaw, near the bifurcation of the artery, and produces difficulty of swallowing and breathing; it is to be carefully distinguished from glandular enlargement. It was first tied by Sir Astley Cooper in 1805. The operation is thus performed: the patient being recumbent, with the head thrown back, and slightly turned to the opposite side, an incision three inches in length is made along the inner border of the sterno-mastoid muscle[e] (Fig. 255) through the integuments, platysma and superficial fascia, extending from near the angle of the jaw to the cricoid cartilage.

The cross veins, descendens noni nerve, and the omo-hyoid muscle should be carefully pushed aside, the sheath opened, and the aneurismal needle introduced between the artery and the internal jugular vein, which is upon the outer side; great care should also be taken not to include the par vagum nerve, which is included in the same sheath.

AXILLARY ANEURISM.

This tumour occupies the arm-pit, and sometimes extends above the clavicle, producing pain and numbness in the arm. The operation of tying the artery *above the clavicle* is thus performed: the patient is placed upon a high table and the shoulder forcibly depressed; an incision (*b*, fig. 255), is made over the clavicle, through the skin and platysma myoides, reaching from the anterior edge of the trapezius to a little beyond the posterior edge of the mastoid; the cervical fascia is then divided, the external jugular vein pushed aside, and the omo-hyoid disclosed; in the triangle formed by this muscle and the clavicle, we find the artery at the outer edge of the scalenus muscle, passing over the first rib, with the nerves forming the brachial plexus above it, and the subclavian vein somewhat in front and below. Great caution should be used in exposing the vessel, on account of the varieties of the arterial distribution in the neck; it should also be recollected the phrenic nerve descends upon the anterior face of the scalenus anticus muscle.

Fig. 255.

The artery is tied also below the clavicle by making a semicircular incision, with the convexity upwards, from near the sternal end of the clavicle towards the acromial, carefully avoiding the cephalic vein and acromial thoracic artery, which pass between the outer edge of the pectoralis major muscle and the deltoid. After dividing the skin, superficial fascia, and pectoralis major, the pectoralis minor will be exposed, between the upper edge of which and the lower edge of the subclavius muscle, the artery will be found deeply imbedded in cellular tissue and fat; the vein is in front, and the axillary plexus of nerves surround the artery.

The arteria innominata has been tied, but without much success where the tumour is large. The patient lying on his back, with his

shoulders raised, and the head thrown back, an incision two inches in length is made on the inner side of the sterno-cleido-mastoid, reaching to the sternum; another incision is made just above the clavicle and through the sterno-mastoid: thus a flap can be turned up; the sterno-thyroid and sterno-hyoid are then to be divided on a director, and the deep fascia exposed; cautiously opening this fascia, the vein is to be pushed aside, avoiding the par vagum, recurrent, and cardiac nerves.

BRACHIAL ANEURISM (FIG. 256).

This is usually the result of violence, and is very often a false aneurism; the tumour is in the bend of the arm, and inconveniences its mobility.

Fig. 256.

The brachial or humeral artery is tied by making an incision on the inner edge of the biceps flexor muscle, of two inches in length, about the middle of the arm. The median nerve will be found first, lying close to the artery; this and the veins are to be carefully separated. It must be borne in mind, that the artery may bifurcate as high as the axilla. If it be necessary to tie the artery in the upper portion of the arm, an incision is to be made over the pulsating vessel, and it will be found on the inner edge of the coraco-brachialis muscle; the nerves and veins are to be carefully avoided.

Deligation of the *radial* and *ulnar* arteries is seldom required except for wounds. Often wounds in the palm of the hand require the tying of the humeral artery. The radial may be exposed in the upper part of the forearm, by an incision through the skin and superficial fascia. By separating the supinator longus muscle from the pronator teres, the artery will be found as it passes over the tendon of the pronator. In the lower part of the forearm the *radial* may be readily exposed by making an incision through the skin and fascia on the outer border of the flexor carpi radialis; and the *ulnar* by an incision on the radial side of the flexor carpi ulnaris muscle.

INGUINAL ANEURISM.

This is a pulsating tumour in the groin, not to be mistaken for a bubo, hernia, &c. The external iliac is tied by making an incision

(*a*, Fig. 257), about 3½ inches in length, commencing on a level with the anterior superior spinous process, and about an inch distant from it; and continued nearly parallel with Poupart's ligament, to a point

Fig. 257.

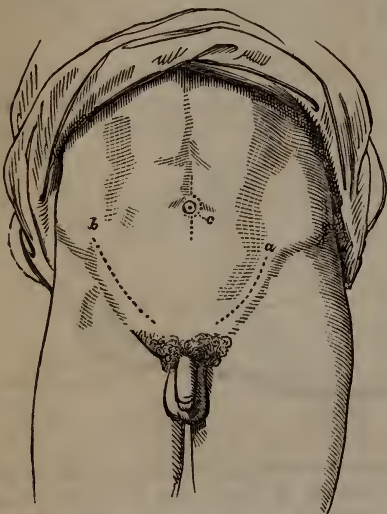
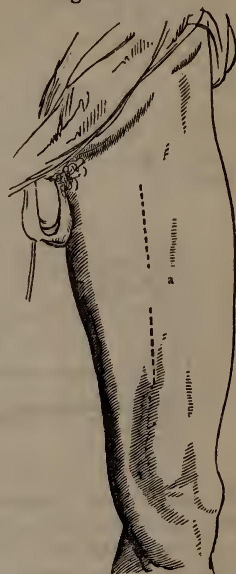


Fig. 258.



1 inch above, and 1½ inches to the outside of the pubes. Carefully cutting through the skin, superficial fascia, tendon of the external oblique, internal oblique, and transversalis muscle, the fascia transversalis will be exposed, with some danger of wounding the epigastric artery. This fascia should be scratched through, and the peritoneum pushed aside, and held out of the way by an assistant with a spatula: the artery will be detected by its pulsation on the inner border of the psoas muscle, the vein being on its inner side. The operation for tying the internal iliac or the common iliac is made by making an incision *b*. The letter *c* shows the incision of Sir Astley Cooper when he tied the aorta.

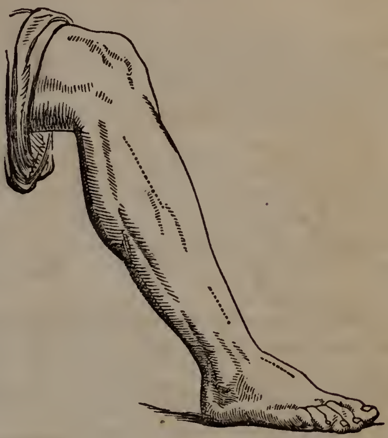
POPLITEAL ANEURISM.

This is of frequent occurrence, and occupies the space between the hamstrings behind the knee, causing pain, numbness and swelling of the leg, disease of the joint, &c.

The operation is to tie the femoral artery. The patient being properly placed, the sartorius muscle is rendered prominent by raising and adducting the thigh. An incision of 2 or 3 inches in length (*a*, Fig. 258) is made upon the inner side of the sartorius muscle, in the upper part of

the thigh, according to Scarpa, where the artery is superficial. The saphena vein is to be regarded in the dissection of the superficial fascia. After opening the sheath, care must be taken not to injure the vein, nor to include the saphenus nerve. Hunter's operation is somewhat below, and in its performance the sartorius must be divided or pushed aside.—The *anterior tibial* artery may be tied in several places: at the upper part of the leg (Fig. 259) by a free incision, to get between the tibialis anticus and extensor communis digitorum. After the division of the superficial fascia, a proper allowance should be made for the breadth of the tibialis anticus, in order to strike the line of division upon the dense fascia between the two muscles. The artery will be found at the bottom of this space, lying on the interosseous membrane.

Fig. 259.



At the lower part of the leg a less incision is necessary, the vessel being more superficial. The wound is made on the tibial side of the extensor proprius pollicis. The venæ comites and anterior tibial nerve are to be avoided. (Fig. 260).

Fig. 260.

On the instep the artery may be secured by making an incision on the fibular side of the tendon of the extensor proprius pollicis.

The *posterior tibial* may be readily tied near the middle of the leg, upon the inner side; divide the skin, superficial fascia, crural fascia, and some fibres of the soleus, and the leg being flexed, the triceps suræ can be pushed aside sufficiently to expose the sheath of the vessels; the artery is to be carefully excluded from the veins and nerve.

At the ankle the operation is simple. A semilunar incision is made, posterior to the internal malleolus, through the skin and superficial fascia, and a thick aponeurosis; this exposes the sheath of the vessels. The veins and nerve are to be excluded.

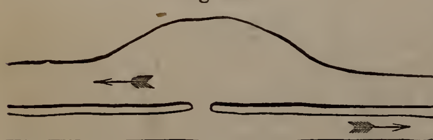
VARICOSE ANEURISM (FIG. 261).

This is usually the result of a wound, and occurs most frequently in the elbow after bleeding. An opening remains both in the artery and in the vein, and a cyst is formed with this double communication. The arterial blood enters the vein, and produces greater or less distension of it. This enlargement of the vein is recognised by a peculiar thrill, resembling the purr of a cat: it may exist for some time without any inconvenience, and is to be removed by tying the artery above and below the sac, and oftentimes it is necessary to tie the vein.

Fig. 261.

Aneurismal varix (Fig. 262) is another variety, occurring in similar circumstances at the bend of the arm. The vein and artery communicate, as in the former, but without any cyst interposed; the swelling is less, but more diffused, and varicose distension of the veins is very great. The limb below the tumour is imperfectly supplied with arterial blood, and, consequently, cold, numb and vitally weak, and also liable to congestion and œdema. It is to be treated by pressure, so as to repress the swelling, and moderate the sanguineous mixture: this will palliate the symptoms, and permit the use of the limb. A permanent cure can only be effected by tying the artery above and below the aperture of communication.

Fig. 262.



Aneurism by anastomosis presents itself in various forms: 1. Capillaries of a portion of integument may be equally and permanently dilated, producing discoloration and slight elevation of the part. This is one form of nævus, or congenital mark, which is attended with no danger, and may be considered as a deformity rather than as a disease. 2d. The structure may consist chiefly of dilated veins fed by arterial branches. This structure is not found in the true skin, but in the adjacent cellular tissue; or it may be submucous, as is exemplified by one variety of hemorrhoid. 3d. The swelling may consist chiefly of dilated and active arteries, supplied with large tortuous veins, which are mere conduits from the tumour; the tumour is erectile, and

varies in bulk and tension, according to the state of the circulation. It often grows rapidly, and brings life into imminent peril.

Its removal may require the knife, excision, or compression.

AMPUTATION.

Amputation is not to be resorted to until all other means of cure have failed. In cases of gangrene, large malignant tumours involving a bone or a joint, diseases of the joints causing hectic and threatening life, and in case of recent injury, where reparation is impossible, then amputation must be performed.

In case of injury, amputation is either primary or secondary:

Primary; when performed immediately after the patient has recovered from the shock of the injury, and before febrile excitement.

Secondary; after suppuration has commenced, and perhaps sloughing. Secondary amputations are also performed for diseases of the bones or joints.

Primary amputations are to be performed when it is impossible to save the injured limb. In military practice, limbs are amputated for injuries which a surgeon might attempt to save in civil practice; there being less opportunity for treatment, and less favourable opportunity for secondary amputation.

Instruments and Dressings.—Amputating knives, catlins, saw, tourniquets, scalpels, tenacula, forceps, needles, ligatures, sponges, bone-nippers, compresses, rollers, retractors, lint, cerate, charpie, adhesive strips, and warm and cold water.

AMPUTATION OF THE THIGH.

The patient having been brought to the edge of the bed, his back is supported by pillows, and his hands held by assistants. The tourniquet is applied over the superficial portion of the artery, about three inches below the groin, so as to interrupt the circulation of blood in the limb. This, like other amputations, may be performed in two ways, either by the circular incision or by the flap operation.

CIRCULAR INCISION.

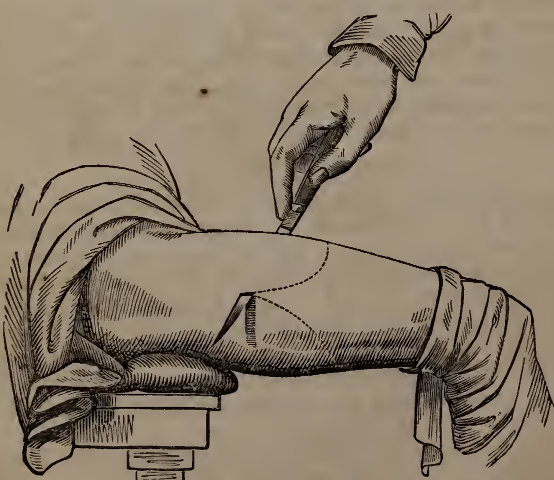
The surgeon stands so that he may use his left hand to grasp the part which he is to amputate, the leg being firmly supported in a horizontal position by an assistant; the surgeon then carries the amputating knife under the limb, and with one complete sweep round the limb, divides the skin, fat, and fascia. A scalpel is then used to dissect the integuments from the muscles, in order that they may be turned up, for two inches, in the same way that one would turn up the cuff of a coat. With the amputating knife, the muscles are now cut through down to the bone, the edge of the knife being inclined upwards, in order that the stump may present somewhat of a conoidal cavity; the muscles are to be slightly separated from the bone, and a retractor applied to pull them upwards. In using the saw, the heel should first be applied on the bone, and a groove made; by steady strokes the bone is divided, care being taken to prevent splintering

and roughness; in case there should be any, it may be removed by bone-nippers. The large vessels can now be tied, and the stump sponged with warm water, in order to detect orifices of smaller ones. After hemorrhage is completely arrested, and the tourniquet somewhat loosened, the end of the bone is to be covered by the muscles and skin, so as to form a rounded stump; the edges are to be retained by adhesive strips, and the ligatures brought out at the corners of the wound. The stump is now covered by lint spread with cerate, and over this a thin pledget of charpie or tow; the whole is supported and covered by a roller, which should be carried once or twice around the patient's pelvis. Having been carefully placed in bed, the stump is supported upon a pillow, and secured to it by pins; over the stump is placed a frame, to take off the weight of the bedclothes. During the winter the dressings may remain on seven or eight days; in summer, only two or three; a poultice previously applied may facilitate their removal. The after-dressings may be repeated once in forty-eight hours. About the tenth day the ligatures may come away, and generally, the wound is healed in three or four weeks. Some suppose that the stump may be better covered by *flap operation*, especially should the integument be thin.

FLAP OPERATION (FIG. 263.)

The original plan of Vermale was, to introduce a knife perpendicularly to the anterior surface of the thigh, and to cut a lateral flap on

Fig. 263.

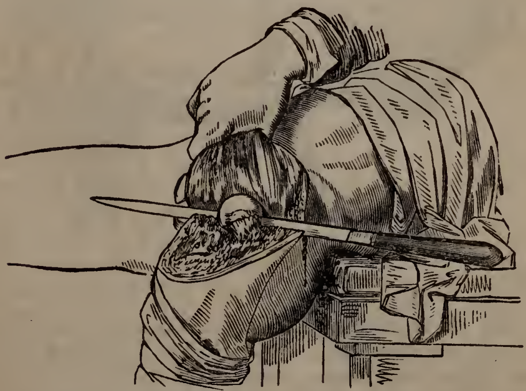


either side. Liston and others prefer an anterior and posterior flap, which prevent the end of the bone rising at the upper angle of the wound, and protruding forwards. These are made by inserting the knife by the side of the thigh, as in Fig. 263, instead of upon its anterior surface. The objections to the flap operation are the injuries to vessels and nerves, by transfixion and oblique division.

AMPUTATION AT THE HIP JOINT (FIG. 264).

This operation is rarely necessary, and is always severe and dangerous. The patient is to be placed on a table, with his pelvis projecting from the edge. The artery is compressed by an assistant, who must be ready to thrust his fingers in the wound formed during the formation of the anterior flap, so that he can grasp the end of the vessel, as soon as it is cut. The knife is entered about middle way between the trochanter major and the anterior superior spinous process of the ilium. By cutting downwards, the anterior flap is formed. The head of the bone is then disarticulated, and the blade of the knife being then placed behind the bone, is carried downwards and back-

Fig. 264.



wards, so as to form a posterior flap; the vessels are to be rapidly secured, and the flap managed as in all other flap operations. By some the formation of a lateral flap is preferred. Very often the selection of the flap will depend upon the character of the wound which may render the operation necessary.

AMPUTATION OF THE LEG.

The length of the stump should, in some measure, depend upon the kind of artificial limb to be used. If the patient is to rest upon his knee, the stump should be short, in order to be bent at right angles.

CIRCULAR METHOD.

The tourniquet having been applied, the integuments are to be divided, dissected up, and turned back for two inches; the muscles are to be divided, down to the bone, by a second circular incision. Then a catlin is to be passed between the bones, so as to divide the interosseous ligament and muscles; a three-tailed retractor is then to be applied, and the bones sawn through together. If the spine of the tibia projects much, it can be removed by a fine saw, or bone-nippers. The vessels are to be secured, and the integuments brought together in a straight line. In this, and all other amputations, the stump may be dressed with water-dressings, unless there is good reason to the contrary.

FLAP OPERATION (FIG. 265).

This is generally preferred, and is thus performed. The surgeon first places the heel of the knife on the side of the limb, farthest from

Fig. 265.

him, and draws it across the front of the limb, in a semicircular direction, making a semilunar flap. When its point has arrived at the opposite side, it is at once made to transfix the limb, and then the larger and posterior flap is cut. In transfixing the limb, care must be taken not to pass the knife between the bones. This amputation may also be performed near the ankle; but, in this instance, it will be necessary to shorten the tendo Achillis after the flap is made. The leg should not be amputated nearer the knee than the tuberosity of the tibia, or the joint will be opened, and inflammation result. Hence *amputation at the knee* is rarely performed, although disarticulation may be readily performed with a large scalpel. In this operation the patella should be allowed to remain.

AMPUTATION OF THE FOOT.

The foot is amputated at two places.

CHOPART'S OPERATION (FIG. 266).

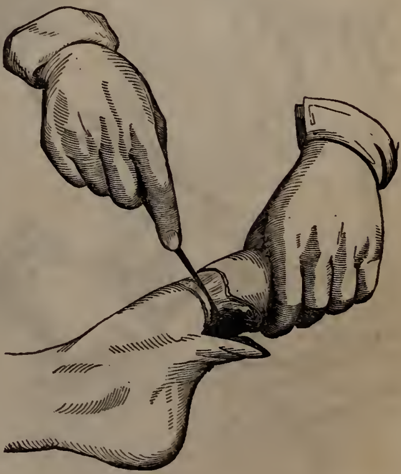
A flap is made from the upper part of the instep, and the disarticulation commenced immediately behind the tuberosity of the scaphoid bone. The bistoury is passed between the scaphoid and head of the astragalus, and then between the cuboid and os calcis: an inferior flap is then made from the sole of the foot.

Fig. 266.

HEY'S OPERATION (FIG. 267).

The disarticulation is commenced immediately behind the tuberosity of the fifth metatarsal bone; separating the fifth and fourth metatarsal bones from the cuboid, the third and second from the external and middle cuneiform bones. The internal cuneiform is either removed or sawed through. The superior flap is made before the disarticulation, and the inferior one subsequently.

Fig. 267.



AMPUTATION OF THE GREAT TOE (FIG. 268).

The most convenient mode of removing this toe is by incisions represented by dotted lines in Fig. 268.

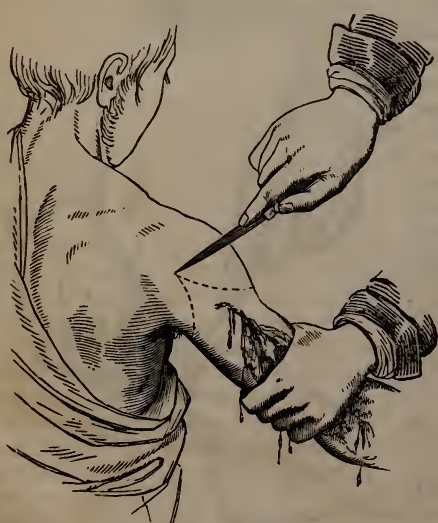
Commencing upon the inner side of the metatarsal bone, and running round the joint obliquely, taking care not to wound the anterior tibial artery. The flap is made from the outer side of the toe. It will cover the head of the metatarsal bone more perfectly, and can be more readily retained in its position than any other.

Fig. 268.

AMPUTATION AT THE SHOULDER JOINT (FIG. 269).

Hemorrhage is to be restrained by pressure with the fingers, or the handle of a key well padded, upon the subclavian artery, as it passes over the first rib. The flaps may be cut by transfixion, or in the manner represented in Fig. 269. The external flap should be made first, out of the deltoid, and then the head of the bone disarticulated. The internal flap is smaller, and made last, in order that the vessel may be secured immediately upon the limb being severed. In some instances it may be necessary to remove the whole of the scapula, and one half of the clavicle. The extent and character of the injury must often determine the shape of the flaps.

Fig. 269.



AMPUTATION OF THE ARM (FIG. 270).

The circular operation is most frequently performed. The artery is compressed by a tourniquet or the fingers, and the skin drawn firmly back. One circular incision will divide the skin and fascia; another will divide the muscles. If the knife is held

so that the edge is directed slightly toward the shoulder, the end of the bone will be found in a conical cavity, and can be well covered by the muscles and skin.

Fig. 270.

The flap operation is sometimes performed. The arm being transfixed, the anterior flap is made first; the vessels are divided when the posterior flap is cut.

Amputation at the elbow is performed by making a single flap from the muscles and skin in front of the joint. The head of the radius is disarticulated first: the ulna is then to be sawed, so as to let the olecranon remain.

Fig. 271.

AMPUTATION OF THE FOREARM (FIG. 271).

The tourniquet is applied to the brachial artery as in other operations upon this extremity.

Two flaps are formed, one on the dorsal, the other on the palmar aspect. These are best made by transfixing and cutting outwards.

The amputation should be performed as near the wrist as circumstances will admit of; although

below the middle it is not easy to obtain sufficiency of flaps. But, the general rule is, to remove as little as possible from the organs of prehension: and operations are attended with less risk to life the farther they are removed from the trunk.

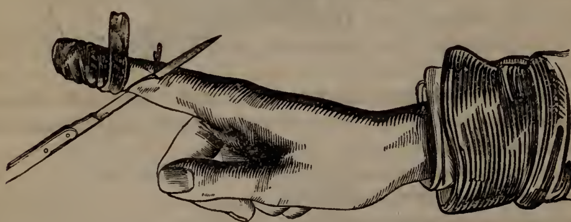
AMPUTATION AT THE WRIST.

The disarticulation of the radio-carpal joint is readily effected by commencing at the styloid process of the radius. A dorsal and palmar flap is made of the skin. The pisiform bone is to be allowed to remain.

AMPUTATION OF THE FINGERS (FIG. 272).

The hemorrhage may be controlled by an assistant's grasping the wrist tightly. The finger may be amputated at a joint or in the middle of a phalanx, though it is important to save as much as possible. The operation may be circular, or with a flap, which should be made from the palmar aspect of the finger.

Fig. 272.



CANCER.

Malignant diseases change the original structure of the part, transform or destroy the surrounding tissues, travel in the course of the lymphatics, contaminate the nearest glands, affect several organs in the same individual, and, if mechanically removed, reappear in or near the cicatrix.

Malignant growths contain granules or nucleated cells, imbedded in a fibro-cellular tissue. They are *composed* almost entirely of albumen. Their *development* is dependent upon perverted nutrition. The *causes* are perpetual local irritation, and a morbid state of the constitution, which may be hereditary. In the ordinary sense of the word, they are not contagious; but cancer-cells injected into the blood of a dog, produce malignant disease of the lungs.

Cancer is a term applied to several kinds of malignant disease; and under this term are included several morbid growths, *encephaloid*, *schirrhus*, and *colloid*, whose physical characters are so various that they have formerly been considered as separate affections.

ENCEPHALOID.

This is often called Medullary Sarcoma, Soft Cancer, and Cephaloma. The word Encephaloid is preferred, because it denotes the resemblance which the morbid product bears to the brain in colour, texture, and consistence. The tumour is highly vascular, which in some measure accounts for the rapidity of growth and the great size to which tumours of this kind attain.

The skin investing the tumour is pale, with numerous veins coursing beneath it. At first it is movable on the tumour, but afterwards ultimately incorporated therewith. The growth is not circumscribed and movable, but fixed and diffused into the surrounding parts. To the touch a sense of great elasticity is imparted, different from the fluctuation of chronic abscess, and different also from the semi-fluctuation which the fatty tumour exhibits, yet somewhat resembling both.

Pain is almost always considerable, often severe and shooting. In some cases it is at first absent; and then the tumour is usually of slow growth, but when it enlarges in the ordinary manner, as it soon does, the pain becomes developed, and continues. The patient is obviously cachectic, and bears on his countenance a plain token of a formidable disease; the features are shrunken and anxious, the hue is sallow, emaciation is begun, the functions of animal life are all disturbed, and hectic is setting in. It attacks more frequently young persons, and may occur in any texture, though most commonly it affects the orbit, testicle, mamma, joints, internal viscera, and lymphatic ganglia.

The section of an encephaloid mass, when fully developed, presents the appearance of an almost homogeneous matter, of an opaque milky colour, ordinarily dotted with spots of pinkish hue, varying in different specimens in number, size, and shape. In consistence it closely resembles the healthy brain of an adult, and may be broken up between the fingers with about the same facility as the substance of that organ; if torn through, the lacerated surface presents a coarsely-granular aspect. Sometimes it is divided into lobules by fibrous bands intersecting the mass; and in tumours of considerable duration, softening will occur, and the skin will give way. So long as the tumour is invested by the integument, it is said to be *occult;* when the skin has given way, and the morbid structure consequently becomes exposed, it is said to be in the *open state.* During the softening of encephaloid, the vessels become opened, the effused blood more readily enters the soft tissue, and mixes with it, than in the harder sorts of cancer; the whole mass assumes a sanguineous appearance, and in this way ence phaloid merges into *Fungus Hæmatodes.* Black granular pigment may likewise enter into the composition of encephaloid, forming *Melanosis.*

There are certain forms of cancer-cells which are characteristic of encephaloid, for instance, parent-cells with young cells in their interior, cells with numerous cytoblasts, and the irregular caudate and ramifying

cells. Of all forms of cancer, encephaloid runs the quickest course, is the most malignant, and causes death in much the shortest time.

SCHIRRUS.

Schirrus usually forms a roundish tumour with a more or less nodulated surface. Its consistence is generally very firm; the tumour in this respect resembling cartilage or even stone; this hardness depends on its fibrous structure, and varies with the toughness, compactness, and amorphous character of the fibres. Its nodules, in cases where the tumour is superficial, are frequently observed on the application of the hand, to be of a lower temperature than the surrounding parts; this is probably dependent on the limited supply of blood to the part. It is much less vascular, and of much slower growth than encephaloid; softening does not take place as rapidly, and, until this occurs, the life of the patient is comparatively safe. A section of one of these tumours sometimes appears of a bluish-white or milky colour, resembling other fibrous tumours; sometimes it presents a more opaque appearance, and is tinged with yellow or red; when softening has commenced a caseous appearance is presented. As a general rule, schirrhus is intimately blended with the surrounding parts, not being enclosed in a capsule, or presenting a definite border. Schirrus has a constant tendeucy to transition into encephaloid or colloid. The mutual relations between the fibres and the cancer-cells vary extremely in schirrus; so much so, that it is frequently impossible to distinguish some parts of the tumour from encephaloid, and others from fibrous tumour. The cells are small, round or oval, and granular. Schirrus contains a viscid fluid, which, when it occurs in excess, forms the transition to gelatinous cancer. The pain is at first slight, and gradually increases as the disease progresses. It occurs more frequently in women, and attacks the mammary gland, generally after middle life.

COLLOID.

This variety of cancer consists of a jelly-like matter, enclosed in cellular cavities, varying from the size of a pin's head to that of an egg; the walls of these cavities are composed of fibrous tissue, such as occurs in scirrhus, and the jelly is colorless and transparent, containing pale cells, which differ from true cancer-cells, being, generally speaking, larger, more delicate, and the walls not being so thick. No true softening or suppuration occurs in this form of cancer; in the intestinal canal, where it is most frequent, the surrounding tissues become gradually infiltrated with this jelly; strictures are thus formed in the gut, and the contents of the canal being pressed on by the soft gelatinous mass, give rise to perforation of the walls. Hence gelatinous cancer is in some degree different in its progress from the other forms of carcinoma.

Treatment.—The treatment of any form of cancer will, in a great

measure, depend upon the development of the disease. A small tumour of a schirrous form may be extirpated, with some chance of success, though not with certainty as to its non-reappearance. When the cancer is open and ulcerated, the treatment should be directed to the constitution, which will, sooner or later, sink with symptoms of hectic.

CLUB-FOOT.

This deformity may be either congenital or acquired. The congenital form is dependent upon some disturbance of the cerebro-spinal system, that produces irregular contraction of the muscles, by which antagonism is destroyed.

The accidental causes by which it may be acquired, are injuries and diseases of the foot or ankle, convulsions, scarlet fever, cicatrices, rickets, &c.

The principal varieties are three:—1. *Talipes Varus*, in which the foot is turned inward, as in Fig. 273, and rests upon its outer edge. There are various grades and modifications of varus. The foot is not dislocated, but the bones deviate from their normal direction, and their articular surfaces are partially separated. The astragalus is least altered in position. The ligaments on the outer side are lengthened, and those on the inner are shortened. The tendons of the tibialis anticus and posticus, and the tendo Achillis, are most contracted; the peronei muscles are relaxed.

Fig. 273.

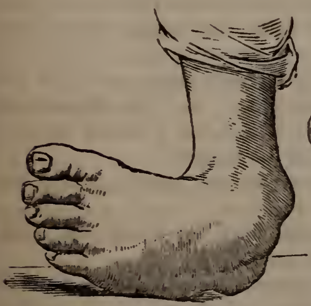
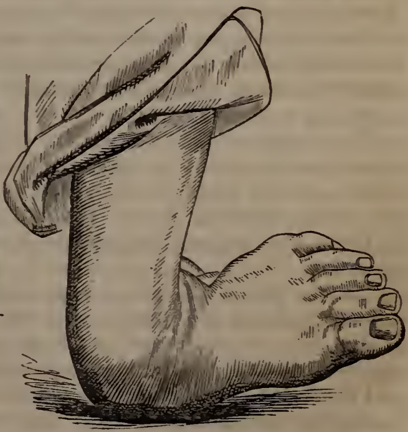


Fig. 274.



2. *Talipes Valgus.* (Fig. 274.) The foot is everted, and rests on its inner edge. It is a rare form of club-foot. The ligaments on the

inner side are relaxed. The peronei muscles are contracted, and the tibialis anticus and posticus elongated.

3. *Talipes Equinus.*—In this variety the foot rests upon the ball, or upon the toes. After a person has walked for a number of years the deformity is increased, as is represented in the drawing (Fig. 275.) The shortening is due to contraction of the triceps tendon, and thickening of the plantar fascia.

Fig. 275.

There are two other varieties; one in which the toes are drawn up by contraction of the extensors, and the patient walks upon the heel; and the other when the dorsum or instep comes in contact with the ground. Besides which there may be various complications of the above.

The *prognosis* will depend upon the degree of contraction, the variety of the deformity, the condition of the bones, and the age of the patient.

Treatment.—Many cases of congenital club-foot may be rectified by constantly wearing a proper apparatus, especially if the treatment be commenced in early childhood; but in confirmed cases it is better to resort at once to Stromeyer's operation of division of the tendons. The operation is thus performed.

The tendon is put on the stretch, and a narrow, sharp-pointed knife is thrust through the skin externally to the tendon; then the edge is directed towards the tendon and the knife withdrawn, cutting the tendon as it escapes.

The operation will facilitate the cure in most cases, provided the subsequent treatment be effectually maintained; and this depends as much upon the fidelity of the parent or nurse in the constant application of the apparatus as upon the skill of the surgeon.

There may be said to be little or no danger resulting from the operation.

Various foot-boards and shoes are to be worn, by which the deformity is gradually and permanently overcome.

The most favorable period for the operation is between six and eighteen months. Great care is required not to produce excoriation and ulceration of the skin in a young child. Oftentimes it is better to remove the apparatus entirely than run the risk of producing fever or convulsions

AFFECTIONS OF THE EYE.

DISEASES OF THE EYELIDS.

HORDEOLUM, OR STYE,

Is a small painful boil, in the cellular tissue upon the edge of the eyelids. It may originate in the sebaceous glands at the roots of the cilia, in the follicles of the ciliæ, or in the cellular tissue. A scrofulous constitution predisposes to the occurrence of them.

Treatment.—Those who are liable to them should pay attention to the condition of the stomach and bowels. Cold applications and nitrate of silver may arrest it; but generally hot fomentations give most relief. After suppuration has occurred, they should be punctured.

OPHTHALMIA TARSI.

This is a chronic inflammation of the edges of the eyelids, occurring most frequently in scrofulous children. The edges are swollen and red; the eyelashes loaded with Meibomian secretion; and the lids are glued together in the morning. There is itching, smarting, and a sensation of stiffness. When the disease is of long standing, the eyelashes fall out, and the new ones are misdirected, and irritate the conjunctiva. In adults it may be the result of catarrhal ophthalmia, or be produced by cold and damp air, or by intemperance. In children it may be the result of eruptive diseases.

Treatment.—Alteratives, laxatives, and tonics. The state of the skin requires attention. Fomentation will remove the incrustations. Loose and misdirected eyelashes are to be removed. An ointment composed of gr. x. of red precip. and an ounce of cerate is to be carefully applied at night; and in the morning the lids are to be bathed with tepid water, and not separated forcibly. In inveterate cases, sulphate of copper and nitrate of silver may be applied to the edges, in case the conjunctiva is thickened; and blisters may be placed behind the ears.

ENTROPION

Is a permanent inversion of the eyelid, and often results from tarsal ophthalmia, from a relaxation of the integuments of the eyelid and spasmodic contraction of orbicularis palpebrarum muscle when long continued, or by contraction of the conjunctiva; constant pain and irritation follow from the ciliæ rubbing against the ball. It is to be distinguished from *trichiasis,* in which the ciliæ are inverted, and irritate the ball whilst the lids remain in their natural position.

The only treatment which can be of permanent benefit, is the excision of a fold of skin, from near the edge of the eyelid; but this is only applicable in certain cases where the cause is relaxation of the skin.

ECTROPION

Is an eversion of the eyelid, caused often by a thickening of the conjunctiva from long inflammation, or from cicatrices upon the skin of the eyelid, resulting from a blow or burn. This is to be cured by bringing the conjunctiva to a healthy condition, by the application of nitrate of silver or sulphate of copper. Should these remedies fail, a portion of the conjunctiva is to be excised. or a portion of new skin to be substituted for the cicatrix.

PTOSIS

Is a falling of the upper eyelid, from a palsy of the third nerve, or from an injury of the levator palpebræ superioris muscle. It is often connected with congestion of the head, and may be a precursor of apoplexy, and should be treated by bleeding, purgatives, mercury, and blisters. If persistent, it may be obviated by removing a fold of the skin from the upper eyelid.

DISEASES OF THE LACHRYMAL APPARATUS.

XEROPHTHALMIA

Is a dryness of the eye, arising either from a want of secretion of the conjunctiva, or, as some suppose, from a deficiency of tears. It is to be remedied by frequently bathing the eye with mucilage.

EPIPHORA

Is a superabundance of tears, so that they run over the cheeks: it should be distinguished from *stillicidium lachrymarum*, which is an overflow in consequence of an obstruction of the channels that convey them to the nose. It arises frequently from scrofulous inflammation; or from the action of chemical or mechanical agents, cold winds, acrid vapours, &c. The treatment will, of course, vary with the cause.

OBSTRUCTION OF THE LACHRYMAL DUCT

Is known by the overflow of the tears, the dryness of the nostril, distension of the sac, and the formation of a small tumour. It often leads to inflammation and abscess. In other instances, it results in thickening of the tubes and duct, which may be much benefited by the use of probes. The puncta and canaliculi may be dilated sufficiently to admit a probe of the same thickness as the ordinary style.

FISTULA LACHRYMALIS

Is an aperture at the inner corner of the eye, the result of a bursting of an abscess caused by obstruction. The inflammation of the sac is to be treated by leeches and cold applications. If suppuration cannot be obviated, the tumour is to be opened as soon as it has become soft and fluctuating. The opening (Fig. 276) should be made parallel

to the margin of the orbit, and below the tendon of the orbicularis. The sac should then be fomented and thoroughly cleansed, and after a few days, should any doubt exist with reference to the perviousness of the tubes and sac, an exploration is to be made by probes.

Fig. 276.

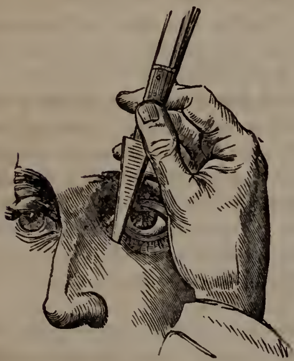


Fig. 277.

Fig. 278.

Should the obstruction be firm, the opening into the sac will remain fistulous, and then a *style* must be introduced. The object of the style is to dilate the strictured portion of the sac. The form and size are shown in Figs. 277, 278. They are usually made of lead, silver, or gold, and sometimes of catgut. Some have thought best that there should be a groove on the style, or that it should be hollow, but this is unnecessary; for although the style may occupy the whole of the calibre of the duct when first introduced, the tears gradually widen it and flow readily by the side of it.

DISEASES OF THE CONJUNCTIVA.

ACUTE CONJUNCTIVITIS.

Symptoms.—Smarting, heat, stiffness, with a feeling as if dust had got into the eye. Subsequently the secretion of mucus increases; which becomes puriform. The vessels of the conjunctiva are turgid and numerous, giving it a bright-red appearance. There is slight intolerance of light and increased flow of tears.

Causes. — Cold or damp, bad condition of stomach, or local irritation.

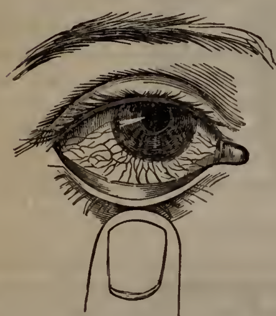
Treatment. — A dose of calomel followed by a saline cathartic; leeches, cold applications, moderately dark room, and a solution of nitrate of silver. The disease may become *chronic;* when blisters behind the ear, and astringent applications to the eye will be useful.

PURULENT CONJUNCTIVITIS.

This, and *Egyptian ophthalmia*, are more severe forms of the same affection, and are infective. The most severe form of inflammation of the conjunctiva is *gonorrhœal ophthalmia;* in this variety the eye is often lost. The treatment must be early and active.

SCROFULOUS CONJUNCTIVITIS (FIG. 279).

Fig. 279.



Symptoms.—Extreme intolerance of light, the eyelids are spasmodically contracted, the head is turned away from the light, there is no general vascularity of the conjunctiva, but a few vessels running towards the cornea, terminate in phlyctenulæ, or pustules on the cornea. This disease is most obstinate and liable to perpetual recurrence, often resulting in ulceration of the cornea, or opacity from effusion of lymph between its layers.

Treatment.—Local applications are of no avail unless the general health be improved. A dose of calomel and rhubarb should be followed by tonics and alkalies, and other general remedies for scrofula, such as quinine and salt baths. The nitrate of silver exercises a more sedative and antiphlogistic influence than any other local remedy. The brow should be painted with ioduretted collodion.

GRANULAR CONJUNCTIVITIS

Is a thick, rough, fleshy state of the palpebral conjunctiva, dependent upon long-continued inflammation; it causes great pain and disturbance to the motion of the eye, and if it continues will render the cornea opaque by its friction. These granulations are dependent upon a hypertrophy of the papillæ of the palpebral conjunctiva, and a thickening of their epithelium.

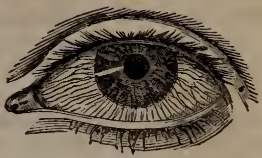
Treatment.—If the granulations are long, they may be removed by the knife or scissors; ordinarily they can be cured by scarification, lunar caustic, and sulphate of copper; at the same time the general health must be attended to, and blisters may be applied behind the ears.

ULCER OF THE CORNEA (FIG. 280).

This most frequently occurs as a result of conjunctivitis, especially of the scrofulous form, but may arise from mechanical injury; it often penetrates the cornea and leaves an opaque cicatrix. When the ulcer is *healthy*, its surface is somewhat opaque, owing to the effusion of lymph; when *inflamed*, vessels will be found approaching it; when

indolent, it is clear and transparent, appearing as if a small piece had been cut out of the cornea. The nitrate of silver is the best application to the inflamed and indolent ulcer of the cornea. If the acetate of lead be used, a white precipitate is formed, which is liable to become fixed in the cicatrix as a dead-white spot.

Fig. 280.



SCLEROTITIS.

This disease is often called rheumatic ophthalmia. It is known by redness of the sclerotica, slight intolerance of light, severe aching pain of the eye and the bone surrounding it, which is aggravated at night. It is distinguished from conjunctivitis by the character of the pain, and redness. In *sclerotitis* the vessels are deep-seated, of a pale pink colour, and run in straight lines from the circumference of the eye towards the cornea; whereas in *conjunctivitis*, the vessels are tortuous, freely anastomose, superficial, and are of a bright-red colour.

Treatment.—Bleeding, purging, together with the administration of colchium, warm baths, and anodyne fomentations; blisters behind the ears, and Dover's powder, are also of great avail.

IRITIS (FIG. 281).

This often is *caused* by injury or cold, but oftener by scrofulous, syphilitic, or gouty taint.

Symptoms.—The iris changes in colour; appears rough or villous; the pupil is contracted, and often filled with lymph: a pink zone surounds the cornea, formed by small vessels from the sclerotica; there is intolerance of light, dimness of vision, a burning pain in the eye, and an aching pain over the brow.

Fig. 281.

Treatment.—The inflammation should be subdued by active antiphlogistic means, such as bleeding, purging, and leeching. The absorption of lymph is to be promoted, and its fresh effusion arrested by the administration of small doses of calomel and opium every four hours, until the gums become affected. The pupil should be kept well dilated by belladonna or stramonium, and the pain must be relieved by anodyne fomentations and nightly doses of opium.

Artificial Pupil.—It is often necessary to form a new aperture in the iris, owing to the pupil having been obliterated by inflammation.

CATARACT

Is an opacity of the lens or its capsules. It may be caused by inflammation or injury, but is more frequently the result of impaired nutrition. There are different varieties of cataract, designated by the terms hard, soft, radiated, capsular, &c.

Symptoms. — The vision becomes gradually impaired, and objects appear as if surrounded by a mist or cloud. The sight is better in the evening, or after the application of belladonna, because the pupil being dilated, more light passes through that part of the lens which may yet be transparent. The pupil is active, and behind it is an opaque body of a grayish-white or amber colour. The catoptric test is the most certain mode of distinguishing it from amaurosis and glaucoma. When a lighted candle is held before the healthy or amaurotic eye, three images of it may be seen: an erect image, that moves upwards when the candle is moved upwards, which is produced by reflection from the surface of the cornea; another erect image, produced by reflection from the anterior surface of the lens, which also moves upwards when the candle moves upwards; and a very small inverted image, that is reflected from the posterior surface of the crystalline, that moves downwards when the candle is moved upwards. In cataract, this inverted image is from the first rendered indistinct, and soon abolished; and the deep erect one is soon abolished also.

Treatment. — There is no cure but by an operation, which should be deferred until the patient is in good health and condition. If the iris moves freely, and there is no tendency to vascular disturbance in the eye or head, the chances are favourable. — There are three modes of operating, before performing either of which the pupil should be dilated by belladonna or stramonium.

Extraction.—An incision is made through one half of the circumference of the cornea, the capsule of the lens lacerated, and the cataract extracted entire.

Couching or Depression.—The object of this operation is to remove the cataract from the axis of the vision, and is performed by a couching needle passed through the outer side of the sclerotica, about two lines from the margin of the cornea.

Producing Absorption. — The needle is introduced in the same manner as in depression, the lens broken up and subjected to the absorbent influence of the aqueous humour.

AMAUROSIS

Is an imperfection of vision, arising from some change in the retina, optic nerve, brain, or fifth pair of nerves.

Symptoms. — The sight is impaired by degrees; at times vision is more impaired than at others; objects appear double, crooked, or discoloured; black spots or flashes of light, a vacant stare, dilated pupil, and but little motion of the eyelids, indicate amaurosis. There is often a want of the natural colour of the pupil, which may cause it to

be mistaken for cataract, from which it is most certain to be distinguished by the catoptric test, as well as by rational signs. The usual causes are circumstances which over-stimulate the retina, such as glaring lights, heats, intemperance, tight neck-cloths; also inflammation, concussion, extravasations, tumours, &c.

Fig. 282.

Treatment. — Should it be inflammatory, produced by wounds, lightning, or exposure to intense light; or if there are plethora, headache, giddiness, turgid countenance, and frequent flashes of light when stooping; or if the complaint has followed a suppression of any accustomed evacuation, or the drying up of an habitual ulcer or eruption, then the antiphlogistic treatment must be adopted,—bleeding, cupping, counter-irritants, and purgatives. Should it be atonic, the result of a protracted illness, great loss of blood, over-lactation, leucorrhœa, or other debilitating circumstances, it is attended with pallid lips, dilated pupils, trembling pulse, and despondency of mind. The patient usually sees best after eating, and in a strong light. The discharge or other source of exhaustion should be corrected, and the system strengthened by fresh air, tonics, quinine, steel, good living, &c. The secretions should be well regulated, and the cutaneous and general circulation be promoted by exercise and bathing.

Should it be sympathetic, supervening on jaundice, some disorder of the stomach, or worms, the general health must be regulated before a cure can be expected. It may arise from tumours near the eye and carious teeth, which should be removed. If it follow an injury of the fifth pair of nerves, the wound should be dilated; or if it be healed, the cicatrice must be cut out. Should it follow the use of tobacco or opium, it may be relieved by a cold shower-bath, counter-irritation, and electricity. Should it be organic, the treatment should be palliative.

STRABISMUS.

Strabismus or *Squinting* is the want of harmonious action of the muscles of the eyeball. It may be caused by the overaction or the paralysis of a muscle. The ordinary *varieties* are the convergent, looking inwards, and the divergent, looking outwards: the former is the more frequent.

It may be congenital, but usually occurs in childhood. Sometimes it is the *result* of imitation; or it may be induced by marks or patches on the nose; but oftener it is occasioned by gastric or intestinal irritation. Cerebral disturbance is another cause, especially when the squint does not come until adult age.

Treatment.—In childhood, where squinting depends on sympathetic disturbance, it is often removed by purgatives, alteratives, or anthelmintics.

Some cases of squinting may be cured by division of a muscle, but not all; in fact, a deformity sometimes results from the operation.

In almost all cases of squinting, there is defective vision in the affected eye: this defect is usually relieved when the operation is properly performed. The patient should be steadied, as for other ophthalmic operations. The eyelids are to be separated by an assistant or speculum, and the eye not to be operated on is carefully to be bandaged.

The conjunctiva is to be seized by a small toothed forceps, about midway between the cornea and the caruncle, so as to form a horizontal fold, which is to be snipped by the scissors close to the forceps, and between them and the cornea; or, this fold of conjunctiva may be divided by an iris knife. After the division, the conjunctiva is to be separated from the sclerotica for a slight distance. The third step consists in the introduction of a blunt hook (Fig. 282), curved so as to accommodate itself exactly to the curvature of the eyeball. The hook is to be passed under the tendon, from above downwards; and the muscle now being secure, it is to be divided by a pair of scissors. If the pupil is now in the centre of the orbit, and if the patient cannot turn the eye horizontally inwards, the operation may be considered as complete. Should a portion of the muscle, or some tendinous fibres remain undivided, they are to be sought for by the blunt hook, and divided. If the fascia is too extensively divided, the eye will become too prominent, or an external squint will result.

After the operation cold water is all that need be applied. The operated eye should be exclusively used for a few days. A fungous granulation often rises from the wound, which may be removed by the knife, scissors, or lunar caustic.

GLOSSARY

OF

TERMS EMPLOYED IN DISEASES OF THE EYE.

Achromatopsia (*a*, priv. *χρῶμα*, *colour*, *ὤψ*, *the eye*), want of power to distinguish colours.

Aegilops (*αἰγίλωψ*, from *αἴξ*, *αἰγὸς*, *a goat*, *ὤψ*, *the eye*), a name given by the older surgeons to a sinuous ulcer at the inner corner of the eye, from its resemblance to the *larmier*, or infra-orbital glandular sac of goats and other ruminating animals.

Albugo (albus, *white*), an opacity of the cornea.

Amaurosis (*ἀμαύρωσις*, *obscuration*, from *ἀμαυρόω*, *to render obscure*), impairment or loss of vision from paralysis of the optic nervous apparatus.

Amblyopia (*ἀμβλὺς*, *dull*, *ὤψ*, *the eye*), impaired vision from defective sensibility of the retina.

Amphiblestroiditis (*ἀμφιβληστροειδὴς*, *the retina*, from *ἀμφίβληστρον*, *a net*, and *εἶδος*, *form*), retinitis, or inflammation of the retina.

Anchilops (*ἀγχίλωψ*, from *ἄγχι*, *near*, and *ὤψ*, *the eye*), name given by the older surgeons to the abcess at the inner corner of the eye, ending in the sinuous ulcer which they called Aegilops.

Anchyloblepharon (*ἀγκύλος*, *crooked*, *βλέφαρον*, *eyelid*), cohesion of the eyelids to each other at their borders.

Asthenopy (*a*, priv., *σθένος*, *strength*, and *ὤψ*, *the eye*), weaksightedness.

Atresia (*a*, priv., *τιτράω*, *to perforate*), closure or imperforation; applied to the pupil, &c.

Blepharitis (*βλέφαρον*, *eyelid*), inflammation of the eyelids.

Blepharoblennorrhœa (*βλέφαρον*, *eyelid*, *βλέννα*, *mucus*, *ῥέω*, *to flow*), first stage of puro-mucous inflammation of the conjunctiva.

Blepharophthalmia (*βλέφαρον*, *eyelid*, *ὀφθαλμὸς*, *eye*), called also Blepharophthalmo-blennorrhœa, puro-mucous inflammation of the conjunctiva in its fully-formed state.

Blepharoplegia (*βλέφαρον*, *eyelid*, *πληγὴ*, *stroke or blow*), paralysis of the eyelid.

Blepharoptosis (*βλέφαρον*, *eyelid*, *πτῶσις*, *a falling down*), called also simply Ptosis, a falling down of the upper eyelid.

Blepharospasmus (*βλέφαρον*, *eyelid*, *σπασμὸς*, *spasm*), spasm of the eyelids.

Bupthalmos (*βους*, *ox*, *ὀφθαλμος*, *eye*) *Oculus Bovinus*, dropsical enlargement of the eye.

Canthus (*κανθος, the rim of a wheel*), angle of the eye.

Cataract (*καταράκτης*, from *καταῤῥάσσω, to throw down with violence, to break or disturb*), opacity of the lens or its capsule.

Ceratitis (*κέρας, horn, cornea*), inflammation of the cornea.

Ceratocele (*κέρας, horn, cornea, κήλη, tumour*), hernia of the cornea.

Ceratome (*κέρας, cornea, τομή, section*), a knife for making an incision of the cornea.

Chalazion (*χάλαζα, grando, or hailstone*), a small tumour of the eyelid.

Chemosis (*χήμωσις*, from *χήμη, a gaping*, from *χαινο, to gape;* or *χύμωσις*, from *χυμὸς, humour, or fluid*), elevation of the conjunctiva like a wall round the cornea, from exudation into the subjacent cellular tissue.

Choroiditis (choroid, from *χόριον, chorion, one of the membranes of the fœtus, εἶδος, likeness*), inflammation of the choroid.

Chromatopsy, or *Chromopsy* (*χρῶμα, colour, ὄψις, vision*), chromatic or coloured vision.

Chroopsy, or *Chrupsy* (*χρόα, colour, ὄψις, vision*), chromatic vision.

Cilia (celo, *to cover or conceal, because they cover and protect the eye*, or from cieo, *to move*), eyelashes.

Cirsophthalmia (*κιρσὸς, varix, ὀφθαλμὸς, the eye*), a varicose state of the blood-vessels of the eye.

Clavus (*the head of a nail*), a certain degree of prolapse of the iris, through an opening in the cornea; the prolapsed portion of the iris being pressed flat like the head of a nail.

Collyrium (*κολλύριον*, from *κολλύρα, a cake; bread sopped according to Scaliger, this being a common application to the eyes*), a medicine for the eyes.

Coloboma (*κολόβομα, mutilation*), applied to fissures of the eyelids and of the iris, congenital or traumatic.

Corectomia (*κόρη, pupil, ἐκ, out, τέμνω, to cut*), operation for artificial pupil by excision.

Coredialysis (*κόρη, pupil, διαλύω, to loosen*), operation for artificial pupil by separation.

Coremorphosis (*κόρη, pupil, μόρφωσις, formation*), operation for artificial pupil in general.

Coreoncion (*κόρη, pupil, ὄγκος, hook*), hook invented for the operation for artificial pupil by separation.

Coreplastice (*κόρη, pupil, πλαστική, the art of making images*), operation for artificial pupil in general.

Cornea (*cornu, horn*), the cornea is so called from its horny appearance.

Corotomia (*κόρη, pupil, τέμνω, to cut*), operation for artificial pupil by incision.

Curette (*French for a small spoon*), *Daviel's* spoon, an instrument used to assist the exit of the lens in the operation of extraction.

Dacryoadenitis (*δακρύω, to weep, ἀδὴν, gland*), inflammation of the lachrymal gland.

Dacryocystitis (*δακρύω, to weep, κύστις, sac*), inflammation of the lachrymal sac.

Dacryo-cysto-blennorrhœa (*δακρύω, to weep, κύστις, sac, βλέννα, mucus, ῥέω, to flow*), blennorrhœa of the lachrymal sac.

Dacryohæmorrhysis (*δακρύω, to weep, αἷμα, blood, ῥέω, to flow*), sanguineous lachrymation.

Dacryolites (*δακρύω, to weep, λίθος, a stone*), calculous concretions deposited in the lachrymal passages.

Dacryoma (*δακρύω, to weep*), stillicidum lachrymarum.

Diplopy (*διπλόος, double, ὤψ, vision*), double vision.

Distichiasis (*δὶς, twice, στίχος, a row*), a form of trichiasis in which the mal-directed eyelashes form a second row, distinct from the others.

Ectropium (*'Εκτροπιον*, from *ἐκ, out, τρέπω, to turn*), eversion of the eyelids.

Encanthis (*ἐν, in, κανθὸς, the corner of the eye*), enlargement of the lachrymal caruncle.

Entropium (*ἐν, in, τρέπω, to turn*), inversion of the eyelids.

Epicanthus (*επὶ, upon, κανθὸς, angle of the eye*), a congenital peculiarity of a fold of skin extending over the inner canthus.

Epiphora (*επὶ, upon, φέρω, to carry*), watery eye from excess of lachrymal secretion.

Exophthalmos and *Exophthalmia* (*ἐξ, out, ὀφθαλμὸς, eye*), protrusion of the eyeball. Exophthalmos is used when the eyeball is otherwise uninjured; exophthalmia, when, in addition to the protrusion, there is disorganization of the eyeball.

Gerontoxon (*γέρων, old, τόξον, a bow*), arcus senilis.

Glaucoma (*γλαυκὸς, sea-green*), a greenish opaque appearance behind the pupil.

Grando (*hailstone*), a small tumour of the eyelid.

Gutta opaca, name given by the Arabians to cataract, as they supposed it an opaque drop in front of the lens.

Gutta serena (drop scene), name given by the Arabians to amaurosis, supposing it to depend on a clear drop fallen from the brain into the eye.

Hæmophthalmos, Hæmophthalmia (*αἷμα, blood, ὀφθαλμὸς, the eye*), sanguineous effusion into the eye.

Hemeralopia (*ἥμερα, day, ὄψις, vision*), night-blindness. It has been also employed to mean day-blindness (*ἥμερα, day, a* priv., or *ἀλαὸς, blind, ὄψις, vision*).

Hemiopy (*ἥμισυς, half, ὄψις, vision*), a defective state of vision, in which one half of objects only is seen.

Hordeolum (hordeum, *barley*), stye.

Hyalitis or *Hyaloiditis* (*ὕαλος, glass*), inflammation of the hyaloid membrane.

Hydrophthalmia, or *Hydrophthalmos* (*ὕδωρ, water, ὀφθαλμὸς, the eye*), dropsy of the eye.

Hyperkeratosis (*ὑπερ, above, κεράς, cornea*), conical cornea.

Hypoœma (*ὑπό, under, αἷμα, blood*), blood in the anterior chamber.

Hypochyma (*ὑπόχυμα*, or *ὑπόχυσις*, from *ὑπὸ, under, χύμα, effusion*), cataract.

Hypogala (*ὑπό, under, γάλα, milk*), effusion of a milky like matter in the anteric chamber.

Hypopyon (*ὑπό, under, πύον, pus*), pus in the anterior chamber.

Iriankiston (*ἶρις, iris, ἄγκιστρον, a fish-hook*), an instrument invented for perforn ing the operation of artificial pupil by separation.

Iridauxesis (*ἶρις, iris, αὔξησις, growth*), thickening or growth of the iris from es udation into its substance.

Iridoncosis (*ἶρις, iris*, and *ὄγκὸς, tumour*), a name formerly proposed by Von Am mon for the same morbid state of the iris, as that to which he has since given th name *Iridauxesis;* but now applied to an abcess of the iris.

Iridectomia (*ἶρις, iris, ἐκ, out, τέμνω, to cut*), operation for artificial pupil by excision.

Iridectomedialysis (*ἶρις, iris, ἐκ, out, τέμνο, to cut, διάλυσις, separation*), operation for artificial pupil by a combination of excision and separation.

Iridencleisis (*ἶρις, iris, ἐν, in,* and *κλείω, to close*), the strangulation of a prolapsed portion of the iris between the lips of an incision in the cornea in certain operations for artificial pupil.

Iridodialysis (*ἶρις, iris, διάλυσις, separation*), the operation for artificial pupil by separation.

Iridoschisma (*ἶρις, iris, 'σχίσμα, fissure*), a fissure of the iris. See *Coloboma iridis.*

Iridotomia (*ἶρις, iris, τομὴ, section*), the operation for artificial pupil by incision.

Iridoperiphakitis (*ἶρις, iris, περὶ, over, φακος, a lens or lentil*), inflammation of the uvea and anterior wall of capsule of the lens.

Keratitis (*κέρας, horn, cornea*), inflammation of the cornea.

Keratonyxis (*κέρας, cornea, νύξις, a puncture*), corneal puncturation in needle operations for cataract.

Korectomia. See *Corectomia.*

Koredialysis. See *Coredialysis.*

Koromorphosis. See *Coromorphosis*

Koreplastice. See *Coreplastice.*

Korotomia. See *Corotomia.*

Lagophthalmos (*λαγὸς, a hare, ὀφθαλμὸς, the eye*), oculus leporinus, or hare's eye. Retraction or shortening of either eyelid.

Leucoma (*λευκόω, to whiten,* or *λευκός, white*), opacity of the cornea from a cicatrice.

Lippitudo (lippus, *blear-eyed*), blear eye.

Luscitas (luscus, *blind of one eye*), fixed misdirection of the eye.

Madarosis (*μαδάρωσις,* from *μαδὸς, bald*), a falling out of the eyelashes.

Marmaryge (*μαρμαρυγὴ, splendour*), an appearance of sparks or coruscations before the eyes.

Metamorphopsy (*μεταμορφόω, to transform, ὄψις, vision*), distorted appearance of objects.

Microphthalmos (*μικρος, small, ὀφθαλμὸς, the eye*), smallness of the eye from imperfect development.

Micropy (*μικρὸς, small, ὄψις, vision*), a state of vision in which objects appear smaller than natural.

Milium (*a millet seed*), a small white tumour of the eyelids or their neighbourhood.

Monoblepsis (*μόνος, single, βλέψις, view*), state in which vision is distinct only when one eye is used.

Mucocele (*μυξα, mucus, κήλη, a tumour*), dropsy of the lachrymal sac.

Muscæ volitantes (musca, *a fly,* volito, *to fly about*), the appearance of grayish motes before the eyes.

Mydriasis (*ἀμυδρὸς, obscure,* or *μυδάω, to abound in moisture,* because it was supposed to be owing to redundant moisture), preternatural dilatation of the pupil.

Myocephalon (*μυῖα, a fly, κεφαλὴ, the head*), a small protrusion of the iris, like a fly's head, through an ulcerated opening in the cornea.

Myodesopsia (*μυῖα, a fly, ὄψις, vision*), muscæ volitantes.

Myopy (*μύω, to shut, ὤψ, the eye*), nearsightedness.

Myosis (*μύω, to shut*), preternatural contraction of the pupil.

Myotomy (*μῦς, a muscle, τέμνω, to cut*), section of muscles. Ocular myotomy, section of muscles in strabismus.

Nyctalopia (*νὺξ, night, ὄψις, vision*), day-blindness. Employed also for night-blindness (*νὺξ, a* priv., or *αλαος, blind, ὄψις, vision*).

Nystagmus (*νυσταγμὸς, steep*), oscillation of the eyeball.

Oculus Bovinus (bos, bovis, *an ox*), ox-eye; see *Buphthalmos.*

Oculus Leporinus (lepus, leporis, *a hare*), hare's eye; see *Lagophthalmos.*

Onyx (*ὄνυξ, a nail*), deposition of matter in the substance of the cornea.

Ophthalmia (*ὀφθαλμὸς, the eye*), a general name for inflammation of the eye.

Ophthalmia Neonatorum (*νέος, young*), purulent ophthalmia of new-born infants.

Ophthalmitis, inflammation of the whole eyeball.

Ophthalmodynia, (*ὀφθαλμὸς, eye, ὀδύνη, pain*), pain in the eye.

Ophthalmology (*ὀφθαλμὸς, eye, λόγος, a discourse*), the science of ophthalmic medicine and surgery.

Ophthalmoplegia (*ὀφθαλμὸς, eye, πλυγὴ, a blow or stroke*), paralysis of the muscles of the eyeball.

Ophthalmoptosis (*ὀφθαλμὸς, eye, πτῶσις, a falling down*, from *πίπτω, to fall*), the protrusion of the eyeball, resulting from paralysis of its muscles.

Oxyopia (*ὀξὺς, sharp, ὤψ, the eye,*) preternatural acuteness of vision.

Pacheablephara, Pachytes (*παχύτης, thickness,* from *παχὺς, thick, βλέφαρον, eyelid*), enlargement and thickening of the eyelid.

Palpebræ (a palpitando, *from their frequent motion*), the eyelids.

Pannus (pannus, *cloth*), a thickened and vascular state of the conjunctiva corneæ.

Periorbita (*περὶ, over*), the periosteum of the orbit.

Phlyctenula (*φλύκταινα, a vesicle,* from *φλύζω, to gush forth*), vesicle filled with a watery fluid.

Photophobia (*φῶς, light, φοβέω, to dread,* intolerance of light.

Photopsia (*φῶς, light, ὄψις, vision*), subjective appearance of light before the eyes.

Phtheiriasis (*φθειρίασις, morbus pedicularis,* from *φθεὶρ, a louse*), pediculi among the eyelashes and hairs of the eyebrows.

Pinguecula (pinguis, *fat*), a small tumour on the white of the eye near the edge of the cornea, apparently but not really adipose.

Pladarotes (*πλαδαρὸς, flaccid*), thickening of the palpebral conjunctiva.

Presbyopy (*πρέσβυς, old, ὤψ, the eye*), farsightedness.

Proptosis *πρὸ, before, πτῶσις, a falling down,* from *πιπτω, to fall*); see *Ophthalmoptosis.*

Psorophthalmia (*ψώρα, scabies, ὀφθαλμὸς, the eye*), ophthalmia tarsi.

Pterygium (*πτερὸν, a wing, πτερύγιον, a small wing*), thickened and vascular state of a portion of the conjunctiva, of a triangular shape, the apex encroaching more or less on the cornea.

Ptilosis (*πτίλωσις, bald*), falling out of the cilia; see *Madarosis.*

Ptosis (*πτῶσις, a falling down,* from *πιπτω, to fall*), falling down of the upper eyelid.

Pupil (*pupilla*), the aperture in the iris.

Retinitis (rete, *a net*), inflammation of the retina.

Rhexis, or *Rhegma Oculi* (*ῥῆξις,* and *ῥῆγμα, a rupture*), rupture of the eyeball.

Rhytidosis (*ῥυτίδωσις, a wrinkling*, from *ῥυτιδόω, to wrinkle*), collapsed or contracted state of the cornea.

Sclerotitis (*σκληρὸς, hard*), inflammation of the sclerotica.

Scotomata (*σκότωμα, dizziness*, from *σκοτόω, to darken*), dark spots seen before the eyes; see *Muscæ Volitantes.*

Staphyloma (*σταφυλή, a grape*), a projection of some part of the eyeball, generally of the cornea and the iris, or sclerotica and choroid.

Staphyloma Racemosum (racemus, *a bunch of grapes*), staphyloma is so called when there is an appearance of several projections.

Stenochoria (*στενοχωρία, narrowness of space*, from *στενὸς, narrow, χῶρος, space*), a contraction, applied to the derivative lachrymal passages.

Stillicidium (stillo, *to drop*, cado, *to fall*), dropping of tears from the eye, in consequence of obstruction of the derivative lachrymal passages.

Strabismus (*στραβίζω, to squint*, from *στραβὸς, twisted*), squinting.

Symblepharon (*σὺν, together, βλέφαρον, eyelid*), adhesion of the eyelids to the eyeball.

Synchesis (*σύγχυσις, mixture*, from *σὺν, together*, and *χύω, to pour*), dissolution of the vitreous body.

Synechia (*συνέχεια, continuity*, from *συνέχω, to keep together*), adhesion of the iris to the cornea or capsule of the lens; in the former case it is distinguished as anterior synechia, in the latter as posterior synechia.

Synizesis (*συνίζησις, a falling together*, from *συνίζέω, to set together*), closure of the pupil.

Tarsoraphia (*ταρσος, tarsus, ῥαφή, a suture*), suture of the tarsal margins in ectropium of the external angle.

Taraxis (*τάραξις, disturbance*, from *ταράσσω, to disturb*), slight external ophthalmia.

Trachoma (*τραχομα, roughness, τραχόω, to make rough*), granular conjunctiva.

Trichiasis (*θρίξ, a hair*), inversion of the eyelashes.

Trichosis (*θρίξ, a hair*), *Trichosis Bulbi*, a small tumour on the front of the eyeball, with hair growing from it.

Tylosis (*τύλος, callosity*), thickening and induration of the borders of the eyelids.

Xeroma, Xerophthalmia, Xerosis (*ξηρὸς, dry*), dryness of the eye, of which there are two kinds, viz., conjunctival and lachrymal.

HAND-BOOK

OF

OBSTETRICS:

WITH

FORTY-ONE ILLUSTRATIONS.

CONTENTS.

OBSTETRICS.

OF THE BONES OF THE PELVIS.

THE pelvis is an irregular bony cavity, situated at the base of the spinal column, and above the inferior extremities, with which it is connected by muscles and articulations, and for which, as well as for the muscles of the trunk, it constitutes "a point d'appui."

When divested of its soft structures, this organ somewhat resembles a basin, and hence its name; for the Greeks called it πελυξ, a wooden utensil of bowl-form; the Latins from them derived the word *pelvis*, which is the term generally adopted by English and American writers. The French call it *le bassin*, the Italians *el bacino*, — all which words have the same signification.

In the adult, the pelvis consists of four parts, viz.: two *ossa innominata*, the *os sacrum*, and the *os coccygis*, but in early life they are more minutely divisible.

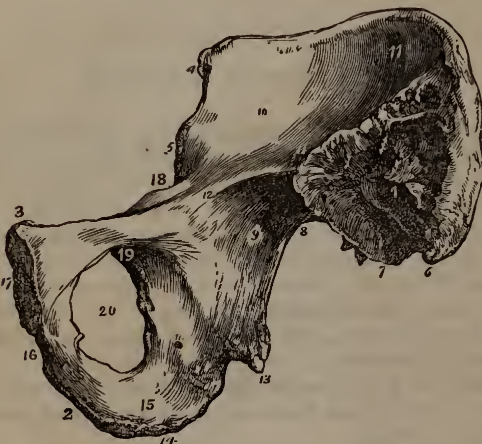
Each *os innominatum* at an early period of intra-uterine life consists of cartilage only. Subsequently bony depositions take place, which at birth have coalesced so as to form three bones separated by cartilage, viz.: the *Ilium*, the *Ischium*, and the *Pubis*. The process of ossification continues till these three bones meet in the acetabulum, two-fifths of which are formed by the ilium, two-fifths by the ischium, and one-fifth by the pubis.

The breadth of each *os innominatum*, from the *anterior superior spinous process* to the *posterior superior spinous process* is six inches, and the height from the *tuber ischii* to the *crest of the ilium*, is seven inches.

Os ilium, hip, or *haunch bone* (Fig. 283), is the largest of the three divisions of the *os innominatum*, and is uppermost in position. It has an *outer* and an *inner* surface; the *outer* [1] is called *dorsum*, and is irregularly convex, and marked by eminences and depressions affording attachments for the glutæi muscles. The *inner* [10] is concave and smooth, and is called *venter;* it is occupied by the iliacus internus muscle. The *lower* portion, the *base*, or *body*,[5] is the thickest part of the bone, and enters largely into the composition of the acetabulum, a cavity for the reception of the head of the femur. Just above the base, the bone narrows into a kind of neck, from which springs the

ala or *wing*. The ala terminates superiorly in a ridge running along its whole extent, called the *crista ilii*, or crest of the ilium. To different parts of the *crest* are attached the oblique and transverse abdominal muscles, the latissimus dorsi, the erector spinæ, and the quadratus lumborum. It terminates *anteriorly* in *the anterior superior*

Fig. 283.

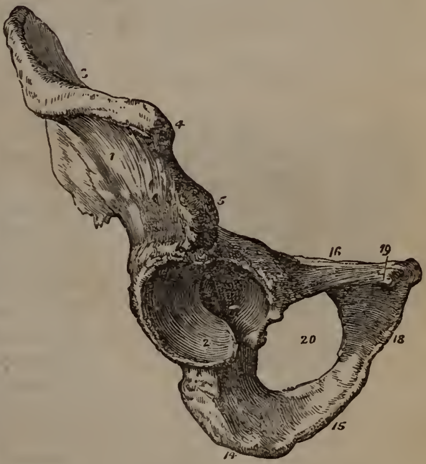


spinous process, and *anterior inferior spinous process*,[4] [5] and posteriorly in the *posterior superior* and *inferior spinous processes*.[6] [7] The *anterior superior spinous process* gives attachment to one end of *Poupart's* or *Gimbernat's* ligament, the *tensor vaginæ femoris*, and the *sartorius muscles*. From the anterior inferior arises the longer portion of the rectus femoris. Into the *posterior* are inserted strong ligaments, which bind this bone very firmly to the sacrum. Below the posterior inferior spinous process there is a deep arch, the *sciatic notch*, which is divided by ligaments into the two *sciatic foramina;* through the *upper*, which is the larger, pass the gluteal, sciatic and pudic arteries, the sciatic and pudic nerves, and the pyriform muscle; through the *inferior*, the pudic arteries and nerve re-enter the pelvis, and the obturator internus muscle passes out. The posterior part of the crest is very rough, and marks the connexion between the ilium and sacrum, called the *sacro-iliac symphysis*, of which there is one on each side of the sacrum. The body of the bone is divided from the ala internally by a ridge running horizontally,[12] forming a portion of the *pelvic brim*, *linea innominata*, or *linea ilia*. The ilium is connected with the ischium and pubis in the acetabulum, and posteriorly with the sacrum.

Os ischium, is the second in size, and lowest in position of the divisions of the innominatum. It is noted for a *base* or *body*, a

spinous process, its *tuberosity*, and *ascending ramus.* The base, or body (Fig. 284[2]), forms the inferior portion of the acetabulum, and is the thickest part. Below this is a narrowed portion called the *neck;* from this a pyramidal process juts out called the *spine*, or *spinous process*, affording attachment to part of the *sacro-sciatic* ligament. It varies in length and direction, and is at times of importance obstetrically, from the impediment which it occasionally offers to the descent of the child's head. In its descent from the neck, the bone bulges out into a protuberance called *tuber ischii*,[14] and turning upwards at an acute angle, becomes the *ascending ramus* of *the ischium.*[15] The internal surface of this bone is smooth and even, and forms one of the *inclined planes* of the pelvic cavity; the external is rough, and gives attachment to the sacro-sciatic ligament, and several muscles. The ischium is connected with the ilium and pubes in the acetabulum, and articulated with the sacrum by ligaments.

Fig. 284.



Os pubis is the smallest and most anterior of the three divisions. It has a *base*, a *body*, two *rami*, a *horizontal* and a *descending*, a *spinous process*, and a *symphysis*. Its *base* is the thickest part, and forms the *anterior* and *smaller portion* of the acetabulum, beyond which the bone narrows, and proceeding forwards forms the *horizontal ramus* (Fig. 284 [16]). This terminates in a wider sheet, and its edge, the point of junction with its fellow bone, is called the *symphysis pubis* (Fig. 283)[17]. From the inferior part of the symphysis, the *descending ramus* (Fig. 284 [18]) proceeds downwards to meet the ascending ramus of the ischium, and with it forms one side of the *arch of the pubis.* On the interior, running along the upper margin of the horizontal ramus, is a ridge, called the *crest* of the pubis, or the *linea pectinea*, which, by its junction with the *linea ilia*, forms the *linea ilio-pectinea*, and at its pubic extremity is a small spinous process, affording an attachment to the pubic end of *Poupart's ligament;* whilst the inner and outer edges of this portion of the bone afford insertion to the abdominal muscles. The os pubis is connected with the ilium and ischium in the acetabulum, with the ascending ramus of the ischium, and with its fellow, by

the symphysis. In the *anterior part* of the os innominatum is seen the *obturator foramen*,[20] formed by the ischium and pubis, which is nearly filled in the recent state by the obturator ligament; through the hole at the superior part pass the obturator vessels and nerve. The object attained by this arrangement is lightness of structure where strength is not needed.

Of the three bones, the ilium forms part of the brim of the pelvis, but none of the outlet; the ischium part of the outlet, but none of the brim; whilst the pubis forms part of both brim and outlet.

Os sacrum terminates the vertebral column; in form it is triangular, with the apex of the pyramid downwards, and rather backwards. It is the lightest bone in the body when its size is considered, and is spongy in structure. It has *four* surfaces, an external and internal, and two lateral, is about four and a half inches in length, four inches in width, and its greatest thickness is about two and a half inches. The *external surface* is convex and rough, and has three or four processes like those of the vertebræ, which may be called *the spinous processes of the sacrum;* anterior to these we find a hollow cavity for the reception of the *cauda equina*, with four holes on each side, which communicate with the cavity, for the transmission of nerves. The *internal surface* (Fig. 285[2]) is smooth and concave to the depth of half an inch, and crossed by four transverse white lines, which mark the former division of its bones by cartilage. There are also four pairs of holes on this surface, which transmit nervous filaments, which afterwards form part of the great sciatic nerve. The upper edge of this bone completes the brim of the pelvis, and from the projection of the central part it is called the *promontory of the sacrum.*[1] The *lateral surfaces*[3] are rough and uneven, the irregularities corresponding with those on the ilium, and forming with them the *sacro-iliac symphysis.*

Fig. 285.

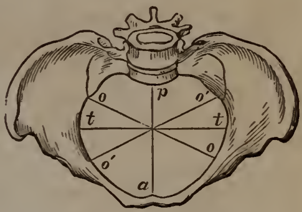
Os coccygis is attached to the apex of the sacrum, and is so named from its resemblance to the beak of a cuckoo.[4] It is composed of three or four pieces, which play upon each other by separate joints, and is of much importance in obstetrical study. The lesser sciatic ligament and the ischio-coccygeal muscles are inserted into it.

Divisions of the pelvis. — The pelvis is divided into the true and false; the upper and the lower; and the greater and the lesser, by the *linea ilio pectinea,* all above that line being the upper, the greater, or

false pelvis, all below receiving the other denominations. The *upper pelvis*, or *pavilion*, is completed by the abdominal muscles, the ilio-lumbar ligament, and the last two lumbar vertebræ. The *lower* or *true pelvis* is of the most importance to obstetricians, and is divided into *brim*, *cavity* or *excavation*, and *outlet*.

The *brim* or *superior strait*, is *defined* by the symphysis pubis, the horizontal portion of the body of the pubis, the spinous process of the pubis, the linea pectinea, the ilio-pectineal eminence, the linea ilia, the sacro-iliac symphysis, and the promontory of the sacrum, and is shaped like the heart on a playing card. It has *three diameters*, an *anterior-posterior*, called also, *straight*, or *conjugate*, from the promontory of the sacrum to the inner edge of the symphysis pubis, which measures about four inches. (Fig. 286, *a*, *p*.) The *transverse*, across the widest part of the brim, and at right angles to the antero-posterior, is about five inches and a quarter. (*t t*) The *oblique* from the *sacro-iliac junction* on either side to the opposite side of the brim above the acetabulum, five inches.(*o o*)—These measurements are of course less in the living body in consequence of the presence of the soft structures. The circumference of the brim is about thirteen inches.

Fig. 286.



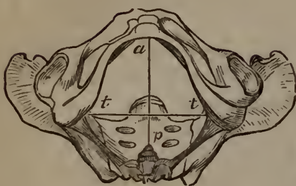
The true pelvis is the *cavity* or *excavation* included between the *brim* and the *outlet*, or between the superior and inferior straits. It is an inch and a half deep in front, three and a half at the side, and five inches from the sacral promontory to the tip of the coccyx. The cavity of the true pelvis resembles a bent cone in shape, and its orifices being somewhat narrowed are called *straits*. A line drawn from the inferior part of the symphysis pubis to the promontory of the sacrum, measures four and a half inches; from the same point to the hollow of the sacrum, four and three quarter inches. The oblique measurement of the cavity from the tuber ischii to the sacro-iliac junction, measures six inches.

The *outlet*, or *inferior strait*, is of an irregularly oval shape, and its diameters are the reverse of those of the superior strait; thus, the antero-posterior diameter, from the arch of the pubes to the tip of the coccyx, is four to four and a half inches. (Fig. 287, *a*, *p*.) The transverse, from one tuberosity to the other, is four inches (*t t*). The outlet is bounded by the tip of the coccyx at the back, by the lower edge of the under fasciculus of the sacro-sciatic ligaments posteriorly and laterally, by the tubera ischii at the sides, by the rami of the ischia and pubes anteriorly and laterally, and by the symphysis pubis in front. Its circumference is about twelve inches.

The planes of the straits.—If a piece of card or paper be cut so as to fit within the anatomical boundary of the superior strait, it will

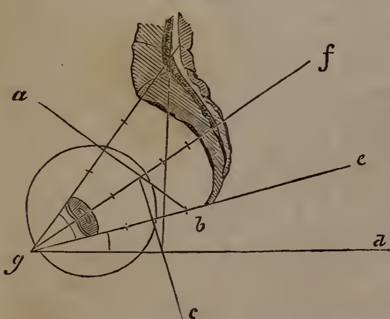
represent the *plane* of that *strait.* Now hold the pelvis in the position it occupies when the individual is either sitting or standing, and it will be found that the plane of the strait has an inclination of about thirty-five degrees, which may be increased or diminished at will by extending or flexing the lumbar vertebræ. The plane of the *inferior strait* may also be described in the same way, viz.: by fitting a card into it. It will be found that they incline towards each other anteriorly, and would meet, if produced, about one and a half inches in front of the pubes. The whole position of the pelvis in regard to the trunk of the body is *oblique,* so that a line drawn through the trunk in the direction of its axis would, in falling downwards, strike on the centre of the symphysis pubis.

Fig. 287.



Axes of the pelvis.—There are two axes of the pelvis, one of the brim or superior strait, which is a line drawn perpendicular to the *plane* of that strait, and, if produced, would extend from the coccyx to a little above the umbilicus; the other, of the *outlet* or *inferior strait,* which is a line drawn perpendicular to the plane of that strait, and, if produced, would extend from the promontory of the sacrum to the central space between the tubera ischii. The axes of the upper and lower straits of the pelvis form an obtuse angle with each other. By combining these axes with the inclination of the pelvis we can obtain a correct notion of the *direction* of the *canal* of the *pelvis,* which, it will be readily seen, is curved. By having a correct knowledge of the axes of the trunk and pelvic entrance, the obstetrician is enabled to place his patient in the position most favourable to the ready descent of the child's head through the brim into the excavation. The direction of the axis of the pelvis will be better understood, perhaps, by a description of "*Carus' curve.*" If one leg of a pair of compasses be set on the posterior edge of the symphysis pubis, in a bisected pelvis, and the other one be opened two and a quarter inches, a circle may be drawn through *g f, g e, g d,* (Fig. 288,) to the point of departure. This circle will represent Carus' curve, and will very nearly coincide with the axis of the pelvis. As the child's head moves through the excavation, its

Fig. 288.



central point coincides with this curve, and if the head of the child should continue after birth to move in the same curve it followed while in the pelvis, it would come back to the point of departure at the centre of the plane of the superior strait. But if the head depart from the coincidence with this curve either in an unassisted or an instrumental labour, the soft parts of the mother will be greatly endangered. Fig. 288 represents "Carus' curve."

The inclined planes of the pelvis. — These are four in number, an *anterior* and a *posterior* on the right side, and an *anterior* and *posterior* on the left side. To demonstrate them, let two vertical cuts be made through the lesser pelvis, and at right angles to each other. The first should be made through the symphysis pubis, and the median line of the sacrum and coccyx, and the second, or transverse, should commence behind the tuberosity of the ischium on either side, and run upwards perpendicularly through the apex of the spine of the ischium, intersecting the *linea ilia* three-quarters of an inch in front of the sacro-iliac symphysis. The direction of these inclined planes is such, that the child's head moving on them will necessarily rotate either under the symphysis pubis, or into the hollow of the sacrum. By these two vertical cuts there will be an *anterior* and *posterior* inclined plane demonstrated on each side of the pelvis, of which the anterior will be the longer.

The muscles within the pelvis deserve notice; for, by being pressed on during the escape of the child's head, they are sometimes strained, and pain is experienced in moving the thigh, and in evacuating the rectum, for some days subsequent to labor. *The levator ani*, one on each side, of the shape of a fan, rises from the pubes just below the brim, the aponeurosis covering the obturator internus, and the spinous process of the ischium, passes down by the side of the vagina, and is inserted into the sphincter ani. On dissecting away these fibres, we observe the *obturator internus;* which, taking its origin from the inner surface of the obturator ligament, and a portion of both the pubes and ischium in the neighbourhood of the foramen, sends off a tendon, which, running round the ischium like a pulley, passes out of the pelvis through the smaller sacro-sciatic foramen, and is inserted into the fossa trochanterica at the root of the trochanter major. *The pyriformis* arises from the anterior surface of the second, third, and fourth divisions of the sacrum, escapes from the pelvis through the larger sacro-sciatic foramen, and is also inserted into the fossa trochanterica, near the insertion of the obturator. *The coccygeus* springs from the spinous process of the ischium, and is attached to the side of the coccyx through nearly its whole extent. *The transversus perinei* rises from the side of the tuber ischii, and is lost upon the sphincter ani, sphincter vaginæ, and the structure of the perineum itself.

Difference in Form between the Male and Female Pelvis and Skeleton. — On comparing the male and female pelves together, we cannot but remark a striking difference in the general appearance and

particular proportions of this organ in the two sexes. We observe that the pelvis of the female is altogether larger and more delicately shaped than that of the male; that the alæ of the ilia spread themselves widely in the lateral direction; while the same parts in the male rise more perpendicularly upwards. The brim is differently shaped; the long diameter in the female being from side to side; in the male from before backwards. The cavity is considerably smaller in the male, deeper, and more of a funnel shape, the sacrum being much straighter, and the tuberosities of the ischia inclining closer together. The outlet is also far less capacious; and this arises principally from the approximation of the ischia, which seldom are more than three inches distant at the widest diameter. The arch of the pubes is formed more angularly than in the female, in whom this part approaches nearer to the perfection of an arch. In the female, too, the rami of the ischia and pubes are smoother on their inner surface, and their anterior edge is turned more outwards. The disposition of the rami helps to enlarge the outlet, and gives an elegance to the whole organ that is wanting in the pelvis of the stronger sex.

All the bones of the male skeleton are firmer and heavier than they are in the female, and more powerfully marked by those irregularities which indicate muscular attachments. The thoracic cavity is comparatively larger, and the acromia are at a greater distance from each other. A line drawn from the head of the humerus, perpendicularly downwards, would fall to the ground altogether clear of the pelvis; but in a well-articulated female skeleton, the same line would rest within the ala of the ilium. It is this difference that gives the broad shoulders to the male, and the swelling hips to the female, and occasions the principal distinction in the outline of the form between the sexes.

OF THE FŒTAL HEAD.

The head is of an oval shape, and largest at its occipital extremity; so that in vertex presentations the largest end necessarily descends first, and its smallest circumference, which is about ten and a half inches, will be nearly parallel to the successive planes of the canal. It is the largest part of the child, and its lateral and superior parietes are most compressible. The bones of the head which require our study are the two *parietal*, the *frontal*, which is divided into two, the *occipital*, and the two *temporal*, for a minute description of which see ANATOMY. The bones of the child's head are not dove-tailed into each other as we find them in the adult, but are separated to some extent by intervening lines and spaces of membranous formation; the lines are called *sutures*, the spaces *fontanelles;* from their having been supposed to distil a moisture, they are also called *bregmata*, from βρέχω, to moisten. The sutures are the *coronal*, *sagittal*, *lambdoidal*, and *squamous.* At the two extremities of the sagittal suture are the two fontanelles, the *anterior* and *posterior*, named from their position.

The anterior is the larger, and is of a quadrangular shape; it is formed by the rounding off of the four corners of the two frontal and the two parietal bones. The posterior is triangular, and formed by the union of three bones, the superior posterior angles of the two parietal, and the upper angle of the occipital. A knowledge of these fontanelles is of great importance in the practice of midwifery, as they are the chief means of diagnosticating the position of the child's head in labour. The great advantage gained from this arrangement of the child's head, is that it allows a more uniform growth and development to the brain than could have taken place had the cranium been solid, and what is perhaps of greater importance, it allows the bones to overlap, and thus permits a certain amount of compression, which enables the head to be pushed through a smaller space than if it had been formed of one continuous piece.

The dimensions of the fœtal head have been variously stated by obstetrical writers, each basing his report upon the result of his own observations. The following table is the best average

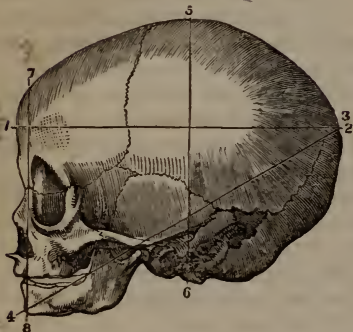
The longitudinal or occipito-frontal diameter, Fig. 287, [1 2] is from	4 in to 4½ in.
The transverse or bi-parietal, from one parietal boss to the opposite	3½ to 4
The occipito-mental, or oblique, [3 4]	5 to 5½
Cervico-bregmatic, [5 6] drawn from a point midway between the foramen magnum of the occipital bone and the external occipital cross to anterior fontanelle	3½ to 4
Bi-parietal	3½ to 4
Trachelo-bregmatic, from the basilar process to the front part of bregma	3½
Fronto-mental, [7 8]	3
Bi-malar	2½
Bi-temporal	2¼
Sagitto-mental, from chin and middle of sagittal suture	4¾
Cervico-frontal, from midway between occipital cross and foramen magnum to forehead	4 compressible to 3
The fronto-mental, [7 8]	3 to 3½
The transverse diameter of the shoulders	4 to 5 reducible to 3
" " " " hips	4 to 5

In general, it may be observed that all the measurements are larger in male than in female children.

Regions of the head.—Vertex. A circle of an inch and a half in radius around the posterior fontanelle as a centre. *Top of the head.*—Sometimes called the bregmatic region; besides which the terms *lateral, chin, face, forehead, base,* are used to define different regions of the head which may present. By the *base* is understood all the immovable parts of it, viz.: the sphenoid in the centre, the temporal bones laterally, together with the bones of the face. The *anatomical* base is incompressible, the *obstetrical* base is compressible.

It is generally remarked that the skull of the male child is a little larger in all its diameters than that of the female. Of sixty male and sixty female children, born at full time, Dr. Joseph Clarke found the average circumference of the head to be 14 inches in the males; 13$\frac{5}{8}$ths in the females. The arch, from ear to ear over the crown, was 7$\frac{1}{4}$th in the males, 7 in the females. Of the 120 examined, only six exceeded 14$\frac{1}{2}$ inches round, and all these were males.

Fig. 289.



OF THE ORGANS OF GENERATION.

These are generally divided into the *external* and *internal.* The external consist of the *mons veneris*, *labia externa*, *perineum*, *clitoris*, *nymphæ*, *vestibule*, *meatus urinarius*, *hymen* in virgins, and *carunculæ myrtiformes* in matrons. The internal are the *vagina*, *uterus*, and *uterine appendages*, which latter are the *broad ligaments*, *round ligaments*, *two ovaries*, and *two Fallopian tubes.*

Fig. 290.

The *mons veneris* (Fig. 290) is placed at the lower part of the abdomen, and upper part of *symphysis pubis;* it consists of dense fibro-cellular, and adipous tissue, and is covered, in the adult, with hair, among the roots of which are numerous sebaceous follicles.

The *labia externa* are two folds of skin and mucous membrane, which commence in front of the symphysis pubis, and extend downwards and backwards to the perineum, where they again meet. The superior junction is called the *anterior commissure* of the vulva, the posterior, is called the *posterior commissure.* Their texture is principally *cellular* and *vascular*, and their use is to protect the organs situated between them. The *perineum* extends from the lower union of the labia externa backwards towards the anus. It is composed principally of highly distensible cellular tissue, but does not possess a great deal of fat, and the skin is very scantily supplied with hair; it is somewhat triangular in shape, and its medium breadth in women who have not borne children is from an inch to an inch and a half, being narrower, of course, in women who have. It is capable of great distension.

The *nymphæ, labia interna* vel *minora,* arise from nearly the same point, at the anterior commissure, and run downwards and backwards about an inch, to the middle of the orifice of the vagina, where they are lost in the general lining of the labia externa. They are covered with mucous membrane, and consist of cellular and erectile vascular tissue, and do not disappear during the distension of the external parts by the escape of the child's head.

The *clitoris* is seated just below the point of junction of the nymphæ, and is the analogue of the male penis, excepting that it has no corpus spongiosum, and no urethra; it is erectile, and extremely sensitive.

The *vestibule* is a triangular space, bounded superiorly by the clitoris, and laterally by the nymphæ; it is covered by smooth mucous membrane, and at its lower portion we find the orifice of the urethra, easily recognised by its soft, prominent, circular rim.

The *urethra* is about an inch and a half long, dilatable, and extends from before backwards and upwards, running under and behind the symphysis pubis.

The *hymen* is a fold of mucous membrane, generally of a crescentic shape, with its concavity upwards, which is found just within the orifice of the vagina; it is generally ruptured at the first sexual intercourse, and its remains constitute what are known as the *carunculæ myrtiformes.* The space between the hymen and the fourchette is called the *fossa navicularis.*

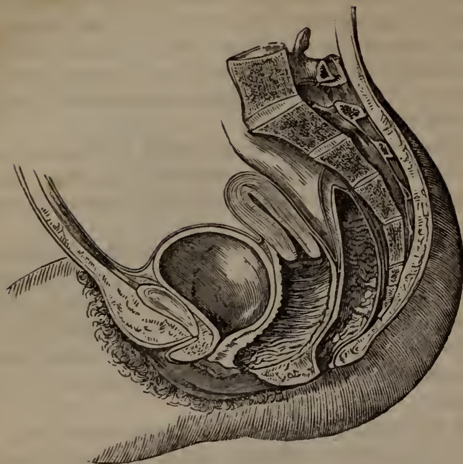
The *external organs* in the aggregate are often spoken of under the name *pudendum.*

THE INTERNAL ORGANS.

The *vagina* is a musculo-membranous canal, extending from its origin in the vulva obliquely through the cavity of the pelvis to the uterus, in its progress describing a curve, which is greater even than that of the sacrum and coccyx, having the neck of the bladder, the urethra and the symphysis pubis anteriorly, and the rectum posteriorly. It is about four or five inches long, and three in circumference, being shorter and more capacious in those who have borne children. It has three coats, an external cellular, a middle muscular, and internal mucous. It is well supplied with blood-vessels, which are much multiplied and interlaced at its anterior extremity, constituting what is known as the *plexus retiformis.* Its mucous membrane is of a pink colour, and is arranged in transverse rugæ anteriorly and posteriorly, which allow great distension of the vagina. Its orifice is surrounded by a collection of muscular fibres, called the *sphincter vaginæ.* It is not much under the control of the will, however, as is shown by the inability to retain injections. At its superior and posterior portion, it receives a reflection of peritoneum. (Fig. 291.)

The *uterus* is placed at the upper part of the vagina, and hangs in the centre of the pelvis behind the bladder and before the rectum,

Fig. 291.



with its long diameter parallel to the axis of the superior strait, and its superior edge a little above the brim of the pelvis. As the axis of the vagina is nearly parallel with that of the inferior strait, it meets the axis of the uterus at an obtuse angle; any deviation from which, implies a displacement of the womb. It is a hollow pear-shaped body, rounder posteriorly than anteriorly, about $2\frac{1}{2}$ to 3 inches long, 2 inches wide, and very nearly an inch thick. Anatomists divide it into fundus, body, and neck. The fundus is that portion above the Fallopian tubes, the cervix is the inferior, cylindrical portion, and the body is that part between the fundus and cervix. (Fig. 292.)

Fig. 292.

The uterus has three coats, a serous, a muscular, and a mucous. It is covered anteriorly and posteriorly by peritoneum, which is reflected laterally to the sides of the pelvis, near the sacro-iliac symphysis, forming the *broad ligaments*, which serve to steady the uterus. The *middle coat* of the uterus is muscular, and classed among those muscles which are called *non-striated*, and which are also found in the middle coats of the arteries. There are three sets of fibres, circular, longitudinal, and oblique, which, by their contraction, tend to diminish the cavity and expel the contents of the uterus. The amount of muscular fibres is much increased during pregnancy. The *internal coat* is generally considered to be a mucous membrane, though there are some obstetrical physiologists who deny it. It extends down into the cervix, whence it is continuous with that of the vagina; it also lines the Fallopian tubes. Its colour is a pale pink except during menstruation. The uterus is supplied with blood by the spermatic and uterine arteries, and with *nerves* from the *aortic plexus*, and from the *hypogastric nerves* and *plexus*, being a mixture of sacral and sympathetic nerves. The *cavity* of the uterus is triangular, its base being directed upwards, and the superior angle corresponding to the points where the Fallopian tubes enter it; in size it is about equal to a split almond, and the internal walls are nearly always in contact. Its inferior angle communicates with the vagina through the canal of the cervix, which is barrel-shaped, and from half to three-quarters of an inch long. The contraction at the upper extremity of the canal is called the *internal os uteri*, whilst that at the lower extremity is called the *os uteri* or *os tincæ;* the latter name from its supposed resemblance to the mouth of the tench. The *shape* of the os uteri varies, in some being transverse, and in others circular, or ragged; the latter especially in women who have borne children. In the mucous membrane of the cervix are found the *glandulæ Nabothi*.

The *broad ligaments* of the uterus are two duplicatures of peritoneum, one on either side, extending from the sides of the uterus to the ilia, in the line which divides the anterior from the posterior inclined planes of the pelvis; they act as *stays* to the uterus and contain the *Fallopian tubes*, which run along their upper margin, and the *ovaries*, which are enclosed in a posterior fold.

The *Fallopian tubes* are two cylindrical canals, about four inches long, which arise from the superior angle of the uterus. They open *obliquely* into the uterus, at which point the canal narrows; it afterwards expands, and again contracts at the point where it opens into the abdomen. In the unimpregnated state it is about the size of a bristle. Externally they are equally thick throughout, except at their terminal extremity, where they expand into a trumpet-shaped enlargement, called *fimbria*, or *morsus diaboli*, which applies itself to the ovary. They have three coats, an *internal mucous*, a *middle muscular*, and an *external serous*, or *peritoneal*, and they are looked upon as the excretory ducts of the ovaries.

The *ovaries* are two in number, and are the analogues of the male testis. They are situated on the posterior face of the broad ligaments, and are attached to the uterus by a ligament of their own, called the *ligamentum ovarii.* They are oval in shape, and have two coats, an external peritoneal, and an internal, the tunica albuginea. On removing these we come to the proper tissue of the ovary, called its *stroma,* which consists of dense cellular tissue, containing within its meshes or areolæ, numerous little vesicles named *Graafian vesicles.* These vary in number and size, the largest being generally seen near the surface of the ovary; they are found early in life, but are more developed about the period of puberty.

The Graafian vesicle has two coats, an *external,* the *tunic of the ovisac,* and *internal,* the *ovisac* (Barry). Within the cavity formed by these membranes is found, floating in an albuminous fluid, the *ovum* or *egg,* which is exceedingly small, and resembles in all its details the egg of the chick. The ovum also contains within its capsule or membrane, which is called the yolk membrane, a granular fluid termed the *yolk,* and in the centre of the yolk a little vesicle, the *germinal vesicle,* and on the walls of the germinal vesicle its nucleus is seen, named the *macula germinativa,* or germinal spot. As each Graafian vesicle rises to the surface of the ovary it bursts, and allows the contained ovum to escape, which is seized by the fimbriæ of the Fallopian tube, and transmitted to the uterus. The cavity of the Graafian vesicle (which still remains in the ovary), becomes filled up with a new deposit, which, being of a yellow colour, is called from that circumstance, *corpus luteum,* or *yellow body.* There is no correspondence between the number of corpora lutea found in the ovaries of a woman, and the number of children she may have borne, as ova are being constantly discharged irrespective of fecundation, hence the corpus luteum is no evidence of previously existing pregnancy.

MENSTRUATION AND ITS DISEASES.

By the term *menstruation,* is understood that function in the female economy by which a certain amount of sanguineous fluid is eliminated by the uterus, and discharged from the vagina every month. This discharge, from its occurring at this regular interval, is called the *menses,* or *catamenia,* and the female in whom it so takes place is said to be *regular.*

This function generally commences at the age of puberty, which in this country is about fourteen or fifteen, and lasts till about forty-five, when it disappears; to this latter period is often applied the terms *critical period, change of life,* &c. During the whole of a woman's menstrual life she is capable of conceiving; after this, her reproductive function ceases. The approach of puberty is announced by other changes than those mentioned. The mammæ are developed, the form becomes rounded, the pelvis expands, and the pudendum is covered

with a growth of hair. The influence of climate in promoting or retarding the approach of puberty, has been shown, by recent observation, to be over-rated, the average period being about the same all over the world.

Mr. Roberton has attempted, and successfully, to show that the age of puberty is about as early in the cold, as in the tropical regions of the earth; and that, were marriages to take place in England at as juvenile an age as they do in Hindostan, instances of very early fecundity would be as common in England as they are in that country. He is of opinion that early marriage and early intercourse between the sexes, where found prevailing generally, "are to be attributed, not to any peculiar precocity, but to a moral and political degradation, exhibited in ill laws and customs, the enslavement more or less of the women, ignorance of letters, and impure or debasing systems of religion." He has also shown, from statistical evidence, that menstruation does not occur more early in the negress than in the white female. Dr. Vaigas, of Caraccas, indeed, in a letter to Professor Meigs, of Philadelphia, affirms that precocious menstruation is more common in the white than in the coloured.[1]

The flow generally returns every twenty-eight days, and lasts from four to six, and the amount discharged varies from four to eight ounces, though about this, there is no certainty, as every woman is a law to herself; what would be a profuse discharge in some, is merely normal in others. The first menstrual flow is generally preceded by languor, lassitude, pain in the back, headache, chilliness, &c., which generally disappear when the discharge takes place. The after occurrences are often unaccompanied by any premonitory or attendant symptoms. The theories that have been brought forward to explain the efficient cause of menstruation are too numerous, and too unsatisfactory to detain us here. The most popular is that which looks upon the maturation and escape of ova as the efficient cause. It is said that every twenty-eight days a Graafian vesicle rises to the surface of the ovary, and during its development and enlargement puts the tunica albuginea and peritoneal coat upon the stretch, and thus becomes a source of irritation; in consequence of which there is an afflux of blood to the parts (that is, to the ovaries, tubes, and uterus), which is discharged into the latter organ; the vesicle finally ruptures, the irritation is removed, and the flow ceases. This view is supported by Drs. Lee, Gendrin, Negrier, Pouchet, Raciborski, and others; but is denied by Dr. Ritchie and others, who contend that ova may be discharged without menstruation, and the reverse, that the maturation of ova is an *effect*, and not a *cause*. That the ovaries *are* concerned, seems proved by the fact that in their absence there is no menstrual flow. The blood that is discharged in menstruation is considered by Mad. Boivin to be identical with venous blood, and the opinion is adopted by Prof. Meigs

[1] Dunglison's Human Phys., Seventh Edition.

and M. Dugés. Although there are many, and the larger number, who look upon it as altered blood, and deficient in fibrine, the first opinion would seem to be supported by the microscopic investigations of M. Donné and others. So far, therefore, as examinations go, they show that there is much resemblance between the catamenial discharge and blood. M. Donné, indeed, affirms that it appears to him to differ in no respect from blood; and that if it occasionally has an acid reaction, in place of being alkaline like ordinary blood, it is simply owing to its being mixed with a great quantity of vaginal mucus, which is always extremely acid, while he affirms that the uterine mucus is always alkaline.

The uterus is congested during menstruation,—so are the Fallopian tubes and ovaries; the vagina is relaxed and distensible, and the os uteri is soft, pulpy, and swollen. All of which conditions disappear when the flow ceases, and the parts return to the normal condition.

DISEASES OF WOMEN.

MENSTRUAL DISEASES.

Amenorrhœa.—By this term is understood an absence of the menstrual flow. There are two varieties: *emansio mensium*, when they have never appeared; and *suppressio mensium*, when, having once appeared, they have been arrested from any cause. The first may depend upon several causes, viz.: congenital malformation, as absence of the ovaries, uterus, or vagina, closure of the cervix, imperforate hymen, &c.; or, it may be dependent upon the health or habits of the patient. The diagnosis is not always easy; if malformation be suspected, recourse must be had to a per vaginam examination, and the defect, if possible, relieved by an operation. If the retention be dependent on constitutional causes, remove them. If the patient is of a full habit, venesection, mild diet, hip-baths, &c. When the reverse obtains, an opposite plan of treatment must be followed: tonics, as iron and its preparations, a generous diet, exercise, warm clothing, hip and foot baths; always bearing in mind that the woman is not *sick* because she does not menstruate, but that she does not menstruate because she *is* sick; or, in other words, that amenorrhœa may be merely a symptom of deranged health.

Suppressio mensium occurs also in two forms; *acute*, when the discharge is arrested during the flow; as by cold, emotions, &c.; and *chronic*, where it occurs in consequence of the acute, or from gradual failing of the health, disease of ovaries, and critical period, &c. The most important point in the early treatment is not to confound the disease with pregnancy. In the *acute form*, if there is much constitutional disturbance, venesection, or cups to the loins, laxatives, baths, and opium to relieve pains. In the *chronic form*, if possible, remove the cause; *tonics*, *aloetics*, and the means above mentioned; there being but a few direct emmenagogues.

Dysmenorrhœa.—Painful or *difficult menstruation.*—This may be dependent on a faulty condition of the system, upon neuralgia of the uterus, or an inflammatory state of that organ, or it may depend on mechanical constriction of the cervix. The discharge is often scanty, accompanied with great pain in the back, loins, fever, &c., and often with the elimination of membranous or shreddy coagula. The *treatment* during the paroxysm is antiphlogistic, as cups to the loins, revellents, baths, anodyne enemata. In the interval, tonics, if debilitated; alteratives, if inflammatory; and dilatation by the bougie, as recommended by Dr Mackintosh, if there be stricture of the cervix. Females afflicted with this disease rarely conceive.

Menorrhagia, is an increase of the menstrual flow either in frequency or in quantity, and it may be either active or passive, the former occurring in robust plethoric habits, the latter in the reverse. The most common causes are nervous and vascular excitements, fevers, internal congestions, displacements of the uterus, and approach of the critical period, &c. It may be confounded with the hemorrhage arising from abortion, foreign growths, &c., within the uterus. The *treatment* varies; in persons of a full habit venesection may be necessary, rest, revulsives, saline laxatives, astringents, &c. In the interval, moderate diet, cold baths, &c. In debilitated cases, rest, tonics and astringents, and opium, good diet, &c. When the hemorrhage occurs about the critical period, it often resists the ordinary treatment. Under such circumstances, the *ergot of rye* often answers a good purpose. It may be given in doses of from 5 to 10 grs., twice or thrice a day. All stimulating and hot drinks should be avoided, and the patient kept in a horizontal position on a hard mattress. As soon as the discharge is entirely arrested, a blister should be applied to the sacrum, and be kept open, and vaginal injections of cold water, or of a solution of acetate of lead, or other astringents, used two or three times a day. In taking the injections, the patient should assume the horizontal position, and endeavour to retain the fluid for a short time. If displacements exist, rectify them, avoid sexual excitement of all kinds, and employ warm clothing, frictions, &c.

Vicarious menstruation.—Seems a provision to obviate the ill effects of suppressed menstruation, by substituting a similar discharge from some other part. It occurs from various parts of the body, sometimes from the gums, nostrils, eyes, lungs, anus, stomach, or even from an amputated stump. The fluid sometimes resembles ordinary blood, at others, it has the characters of the catamenial fluid. It may occur at any time, and in any constitution. It is not, however, usually attended by any serious consequences.

Treatment.—After once occurring, the patient should be watched, and the system relieved by some other means; venesection, astringents, sedatives, mineral acids; and, if debilitated, tonics may be used.

Leucorrhœa.—An excessive and altered secretion of the mucus furnished by the membrane lining the vagina and uterus, by the fol-

licles of the interior of the cervix uteri, and by the lacunæ of the vestibulum; generally white, or nearly colourless and transparent, sometimes yellow, or green, or slightly sanguineous, and of varying degrees of consistency. The amount of constitutional derangement depending on the severity of the affection, and the susceptibility of the patient (*Ashwell*).

The seat of the discharge may be diagnosticated by examining its characters. If it be of a jelly-like consistence, resembling partly coagulated albumen, and taking place at intervals, and in small quantities at a time, it probably comes from the muciparous follicles of the neck of the uterus.

If, on the contrary, it be of a whey-like or creamy consistence, and varying in colour from white to green, or brown, it probably comes from the mucous membrane of the vagina. In such cases the mucous membrane is commonly found studded over with red points, the inflamed orifices of mucous follicles.

There is sometimes an offensive sanious ichor discharged, whose origin is probably in the cavity of the uterus, or the Fallopian tubes themselves.

Acute vaginal leucorrhœa is accompanied by a sense of weight, heat and soreness in the vagina, tenesmus, irritation of the bladder, pain in the lower belly and thighs, &c. The discharge, at first thin and acid, becomes whitish, or yellowish, and more consistent. The occurrence of the discharge generally relieves the urgent symptoms.

Treatment.—If the patient be plethoric, bleeding should be practised, either general or local. Fomentations, rest, spare diet, and vaginal injections should also be used.

Chronic vaginal leucorrhœa is one of the most frequent diseases during menstrual life; sometimes, however, it precedes the menses. By most writers it is considered as a local disorder, inflammatory in its nature. It is frequently caused by cold, excessive coition, parturition, pessaries, displacements, and irritating food. There is seldom any pain accompanying it. If the discharge be great, weakness and pain in the back and loins may ensue.

The *treatment* consists in the use of depletory measures if required; the removal of pessaries, tonics if the patient be weak; opium if pain be present; and the use of the balsams and astringent injections.

The *uterine leucorrhœa*, which is also often accompanied by constitutional symptoms, requires the use of depletory measures at times, with the use of astringent injections, and tonics if the health be feeble, particularly the preparations of iron. A solution of nitrate of silver, applied by means of a speculum to the interior of the cervix uteri, has succeeded when other means have failed. Should there be any suspicion of a syphilitic taint, the remedies proper in such cases should be used.

HYSTERALGIA, OR IRRITABLE UTERUS,

May be defined, a permanent and painful sensibility of the uterus, especially of its neck; often accompanied by increased frequency of pulse, a dry hot skin, and generally, in protracted cases, with gastric and renal derangement. This disease commonly occurs in the middle period of life, though it is sometimes met with in early youth.

The *local symptoms* are pain in the small of the back and sacrum, extending down the thigh to the knee, and around the brim of the pelvis to the lowest part of the abdomen. There are also sometimes erratic pains in the thorax and loins. The character of the pain is that of *soreness*, slight pressure relieves it, but it is aggravated by rough handling. Sometimes it is spasmodic, like those of abortion. Dewees describes the pain as often pulsating.

The pain is aggravated by excitement of any kind, by exercise, and sometimes by standing. Straining, either in defecation or urination, constipation, flatulence, and diarrhœa, all aggravate it.

A per vaginam examination may prove the uterus to be either displaced or engorged, but not altered in form, size, or density; extremely painful to the touch, in the body as well as in the neck; the pain is "as if a knife had been plunged into it."

Causes. — Among the predisposing causes may be placed, education, fashionable life, prolonged lactation, and temperament. Among the exciting causes, bodily exertion during menstruation, astringent injections, abortions, prolapsus and sudden arrest of the menses from any cause.

Diagnosis. — From neuralgic dysmenorrhœa, by the constancy of the pain. From acute inflammation of the cervix, by the absence of heat, swelling, and throbbing; by the absence of discharges, and by the slight change of the cervix compared with the amount of suffering.

Pathology.—Gooch considers it a permanently painful condition of the uterus, neither accompanied by, nor tending to produce change in its structure. Ashwell considers it a modified inflammation, or at least, closely allied to inflammation or congestion.

Treatment.—Two indications present themselves, viz.: 1. To mitigate local suffering; 2. To sustain and improve the general health. The first indication will be fulfilled by the use of anodynes, either by the mouth, rectum, or applied directly to the uterus itself; by the application of nitrate of silver, by dilating the cervix by bougies, and by anointing the cervix with anodyne unguents, especially the unguent. aconiti. The second indication, by rest, exercise in a recumbent posture, or, if it suits best, on foot or horseback, tonics, nutritious food, cold bath, or the douche, and cheerful society. Scarifications to the neck of the uterus are highly recommended by Dr. Ashwell, especially if there be any congestion. The introduction of the pessary is often followed by marked relief, especially if there be any descent.

DISPLACEMENTS OF THE UTERUS.

Displacements of the uterus are of three kinds, viz., *Prolapsus*, *Retroversion*, and *Anteversion*.

PROLAPSUS UTERI,

Signifies a sinking of the uterus nearly or quite down to the os externum; when it protrudes beyond the vulva it is called *procidentia uteri*. The position of the uterus has been already described. (Page 493.)

Causes. — Heaviness of the uterus itself; hence it often occurs in early pregnancy; congestion of the uterus; ovarian and other abdominal tumours; tympanitis; distension of the colon; relaxation of the ligaments, and too early "getting up" after labour; tight lacing, dancing, running, or any severe muscular exercise; leucorrhœa and other exhausting discharges, straining, coughing, &c.

Symptoms.—In some cases there is no suffering at all, or merely a sense of fulness. At others, there is pain in the back and groin, extending down the thighs to the knees or toes. The patient suffers great distress in standing or walking, and in voiding the urine and fæces. Strangury is sometimes present from the extension of the irritation to the bladder. Sometimes leucorrhœa is present, at others menorrhagia. The stomach and bowels sympathize; there is anorexia, loss of tone in both stomach and bowels, constipation or diarrhœa, and sometimes tympanitis. The patient often becomes morose and irritable. In *procidentia* the patient often suffers no other inconvenience than that arising from the external presence of the organ, or its acrid discharges.

Diagnosis. — In addition to the above symptoms, a per vaginam examination reveals the nature of the disease. The presence of the os uteri, at the lower part of the tumour felt in the vagina, is almost infallible. From prolapsus of the bladder, rectum, or vagina, it may be distinguished by their greater softness and elasticity, and by the absence of the os uteri. *Procidentia* may be distinguished from partial inversion, by the presence of the os uteri at the lower portion of the tumour; by the absence of severe floodings, and by the smooth surface of the tumour.

Treatment.—Opinions differ much on this point. Nearly all agree as to the necessity of mechanical support in most cases. The difficulty is, *as to the mode*. In slight cases, rest in a horizontal position, with cold or astringent injections, is often sufficient. In prolapsus after confinement it is particularly necessary. Bandages, when they relieve, act by supporting the abdominal muscles, and those of the back, hence they may be useful in women who have borne many children, and in whom these muscles are much relaxed. They can never be regarded as *uterine supporters*. In decided prolapsus, and almost nvariably in procidentia, mechanical support by means of *pessaries*

becomes necessary. These differ in shape according to the end to be obtained, and the peculiar views of the practitioner using them. The mode of introduction is as follows: The patient being placed on her side or back, the long diameter of the instrument is to be placed in accordance with the long diameter of the lower outlet; then gently introduce by steady pressure. When fairly introduced it must be partially turned so as to place it transversely across the pelvis and above the tubera ischii. The globe pessary is more easily introduced and requires no turning. In procidentia the uterus should be first returned, and then retained by means of the pessary. In addition to these means the patient should use cold injections, or hip-baths, astringent injections, rest, for a season at least, tonics, if her health be enfeebled, laxatives, if the bowels are constipated, and astringents if diarrhœa be present. It has been proposed to cure the disease by cutting out part of the vagina, or to produce cicatrices by caustic, which, by their contraction, shall support the uterus.

RETROVERSION OF THE UTERUS.

By this term is understood a tilting backwards either of the fundus alone, or of the entire uterus, so that, if the pelvis be of the full size, the fundus will be depressed below the promontory of the sacrum. This displacement is called *retroflexion*, when the fundus alone is forced backwards; *retroversion*, when the entire organ takes that position.

Causes.—It most commonly occurs in women who have borne children, or who are pregnant, and is caused by a sudden impulse backwards either by a distended bladder, by long standing, or by a sudden expulsive effort.

During the early months of pregnancy the uterus is peculiarly liable to this displacement.

Most of the instances of retroversion are attributable to a distended bladder; for, as this organ fills, it rises, and pulls the lower portion of the uterus upwards; at the same time the fundus is pushed backwards, by the repletion of the bladder; the os uteri therefore presses against the neck of the bladder and produces retention of the urine; the fundus presses against the rectum and prevents the passage of fæces, which thus accumulate above the point of pressure, and not only prohibit the ascent of the fundus to its normal position, but really force it lower. The accident may also happen from falls, shocks, lifting weights, and, according to Churchill, in the early days of menstruation, when the uterus is increased in weight by the afflux of blood. The growth of tumours in the neighbourhood of the fundus is also a cause.

The *symptoms* are violent bearing-down pains, sense of fulness and distension about the loins and hollow of the sacrum, dragging and tension in the groins, and inability to pass fæces or urine. A per vaginam examination reveals the os tincæ thrust up behind the sym-

physis pubis, and the vagina seems to be obstructed by a hard body, which is the fundus turned down into the hollow of the sacrum.

The *treatment* consists in emptying the bladder and rectum, and pressing up the fundus by two fingers in the rectum, assisting them, if necessary, by a finger of the other hand in the vagina, by which the os uteri can be hooked down. Venesection is sometimes necessary to relax the system. Sometimes merely emptying the bladder and rectum are sufficient, the uterus recovering itself through the muscularity of the round ligaments. Sometimes it is necessary to rupture the ovum, and let the uterus condense itself. At others, tapping the uterus is required. The after-treatment is, rest in a horizontal posture, and the avoidance of the distension of the bladder and rectum. Prof. Simpson's "*womb-sound*" has been successfully employed in restoring the organ to its normal position in cases of retroversion of the unimpregnated uterus.

ANTEVERSION OF THE UTERUS.

Anteversion is that displacement in which the uterus occupies a transverse position in the pelvis, the fundus being directed toward the symphysis pubis. *Anteflexion* is a bending of the uterus at the neck, by which the fundus is caused to approach the pubes.

Causes. —Violent expulsive efforts either during or after emptying the bladder, accumulation of fæces in the rectum, blows, falls, obstinate diarrhœa, contraction of the round ligaments, and pregnancy in the early months.

Symptoms. — Weight in the pelvis, pain in the hypogastrium and in the perinæum, sense of dragging from the loins, all increased by standing or walking. By a per vaginam examination, the pelvis will be found blocked up by a tolerably dense body; the fundus uteri will be felt anteriorly, the cervix posteriorly. A sound introduced into the bladder will impinge upon the displaced fundus, which will be distinguished from stone, however, by the absence of the clicking sound.

Treatment. — Many cases may be cured by directing the patient to let the bladder fill, and to keep the rectum empty. The organ may be readily replaced, if it have not contracted adhesions, by hooking down the cervix with the forefinger of one hand, while the fundus is elevated by the other; the patient should afterwards be kept in bed on her back for some days.

Various forms of pessaries have been recommended for the treatment of these diseases, but they are rarely necessary.

PREGNANCY, ITS PHENOMENA AND DISEASES.

Before entering upon the consideration of the signs by which a woman knows herself to be pregnant, it will be proper to examine what further changes take place in the uterus itself. It has already been stated that the uterus becomes more vascular, after conception

has taken place, and that its interior lining becomes altered; the vessels, arteries, veins, and lymphatics are increased in size, and it has been said by Dr. Robert Lee, that the nerves are also increased in number, although this latter change is doubted by many. The proper tissue of the uterus also undergoes great changes. In proportion as the ovum is developed, the fibres are separated from each other, and increased in number, leaving spaces between them which are filled by the enlarging vessels (Fig. 293). That the amount of substance is

Fig. 293.

absolutely increased, is shown by the difference of weight between a virgin uterus and one at full term, just emptied; the former weighing one ounce, the latter nearly twenty-four. The increase in the development of the womb is not uniform from the first, but commences at the fundus, gradually extending to the body, and last of all, about the fifth month, to the cervix. Up to the fourth month the uterus is generally retained entirely within the pelvis; shortly after this, its fundus may be felt above the symphysis pubis in thin persons; about the fifth month it reaches midway between the pubes and umbilicus, gradually ascending till the eighth month, when it is as high as the ensiform cartilage. After this, although it increases in capacity, it no longer ascends; on the contrary it rather falls. Its capacity is also greatly increased: according to Levret's calculations, its superfices may be estimated at 339 inches, and its cavity will contain 408 inches; its length being from 12 to 14 inches, its breadth from 9 to 10, and its depth from front to rear, 8 to 9 inches. The weight of the whole organ, and its contents, at full term, is about twelve pounds. The *form* of the gravid uterus differs also from that of the unimpregnated state, and this difference appears to depend in a great measure upon its increase in size, and the form of the cavities it occupies. In the non-gravid state, when it occupies the cavity of tho pelvis, its anterior

surface, corresponding to the bladder, is flattened, while its posterior aspect is convex. The reverse, however, obtains during the latter half of pregnancy. The anterior surface is now *convex*, being merely covered by the yielding anterior wall of the abdomen; whilst posteriorly the uterus is nearly concave, corresponding to the prominence of the lumbar vertebræ. This condition of things may be readily ascertained by examining the abdomen of a pregnant female in the last months of gestation, whilst she is lying down.

The situation and position of the uterus are also changed: in the non-gravid state, the fundus inclines somewhat backwards, the os uteri being nearly in the centre of the pelvic cavity, the gravid uterus, during the latter half of pregnancy, has its fundus inclined forwards, and the os uteri directed backwards towards the upper part of the hollow of the sacrum.

During the first month, the changes are not very appreciable, the uterus is larger, softer, and more vascular, the *os* and *cervix* are soft, and cushiony, as during the menstrual period, and the transverse fissure is more *oval.*

During the second month, abdomen somewhat flat, cervix increased in size, and the os uteri can be felt lower than natural; its shape also is changed, being round and smooth in primiparæ, while in multiparæ it is larger and irregular in shape. The canal of the cervix is closed by a gelatinous plug.

During the third month, slight protrusion of the abdomen, os uteri not so easily reached, and somewhat changed in position; it is no longer in the middle of the pelvic cavity, but inclines towards the hollow of the sacrum, while the fundus approaches more nearly to the anterior parietes of the abdomen.

During the fourth month, the fundus may be discovered two or three inches above the symphysis pubis in thin persons, by pressure, having first relaxed the abdominal parietes, and emptied the bladder and rectum.

During the fifth month, the cervix is drawn out by the expanding uterus and shortened, and the fundus may be felt halfway between the symphysis pubis and umbilicus.

During the sixth month, the cervix has lost very nearly one-half its length, the fundus is as high as the umbilicus, and the depression of the navel begins to disappear.

During the seventh month, the cervix is only half its original length; the fundus rises a little above the umbilicus, which often becomes pouting. The head may also be felt per vaginam by ballottement, and the movements of the child detected through the abdominal walls.

During the eighth month, the cervix is not more than a quarter of an inch long, abdomen increased considerably in size, and the os uteri so high as scarcely to be reached. The fundus is about midway between the umbilicus and scrobiculus cordis.

During the ninth month, the neck is obliterated, so that upon making an examination, we find the vagina closed superiorly by the rounded lower end of the uterus, and in primiparæ the fundus is at the scrobiculus cordis. During the last few weeks of pregnancy the fundus sinks a little, the abdomen falls, the os uteri appears only as a little dimple, and its edges are thin and membranous; it occupies now the upper part of the hollow of the sacrum. In women who have borne many children the cervix does not entirely disappear.

SIGNS OF PREGNANCY.

These are divided into the *rational* and *sensible*, the latter of which only can be depended upon, as the former may occur in abnormal conditions of the uterus, independent of pregnancy. The rational signs occur in the earlier months; the sensible or physical, after the ovum is somewhat developed. The diagnosis is at all times difficult in the early periods.

Rational signs.—Plethoric condition and fibrinous blood; variations in temper and taste; altered functions of stomach, bowels and kidneys; change in the colour of the skin; *cessation of the menses*, though not invariable, is one of the earliest signs; *morning sickness*, from the sympathy between the uterus and stomach; *salivation*, not to be confounded with mercurial ptyalism, from which it may be distinguished by the absence of sponginess of the gums, and the peculiar fetor; *enlarged* and *painful mammæ*, and in many cases a *darkened areola* and enlargement of the follicles situated in it, with a soft and moist state of the integuments; *milk in the breast*—this fluid is sometimes found in the breasts during the latter stages of gestation, but is not invariable, nor always to be depended on when present. *Quickening;* this sensation has been variously described; some authors say it is caused by the first movements of the child; others assert that it is caused by the sudden rise of the uterus from the pelvis into the abdominal cavity, producing fainting, sickness, &c. As a sign of pregnancy it is almost valueless, since females are very apt to be deceived in this respect by the movements of flatus in the bowels, by occasional spasmodic twitching of the abdominal muscles, &c.

Kiesteine. — During pregnancy a peculiar substance, analogous to caseine, is found in the urine, forming a thin pellicle upon its surface when it is allowed to stand, and emitting an odour resembling cheese. It is not, however, peculiar to pregnancy, but may occur whenever the lacteal elements are not eliminated by the mammary glands. At the same time the probabilities are as 20 to 1, that the female is pregnant, if the kiesteine be present.

Blue colour of the vagina has also been looked upon by M. Jacquemier, and M. Parent Duchatelet, as among the rational signs of pregnancy.

The SENSIBLE OR PHYSICAL SIGNS OF PREGNANCY, are those by which the presence of a fœtus in utero are detected by an exploration of the organ itself.

Enlargement of the abdomen begins to be perceptible about the end of the second month; before this the abdomen is often flatter than usual. "A ventre plat, enfant y'a."

Fig. 294.

A, vertical section of sacrum; B, rectum; C, uterus and ovum; D, bladder; E, finger in the vagina with its extremity pressing up the uterus.

Ballottement is practised thus: The patient should be in the *upright position*, or at least in a semi-recumbent posture: now let the operator place the left hand upon the fundus uteri to steady it, and introduce the index finger of the right hand to the cervix uteri, then suddenly but gently jerking the finger upwards, he will feel a sensation as if something had receded from it, and then settled down upon it again. This test is most available about the fifth and sixth months. (Fig. 294.)

Auscultation was applied to the detection of the presence of a *fœtus* in utero, first by M. Mayor, of Geneva. Three sounds have been heard by different observers, viz.: that of the fœtal heart, that of the placental circulation, and that of the pulsation in the cord. The first of these is the most certain; the second may be imitated by the pressure of a tumour upon any great vessel, and the last can only be heard under very favourable circumstances, as where the cord lies between the child and the abdomen of the mother. The situation in which the fœtal heart is most distinctly heard, is about the middle point between the scrobiculus cordis and symphysis pubis, generally to the left. The frequency of the pulsation is about double that of the adult, ranging from 120 to 140 per minute, and entirely independent of the maternal circulation. The sound resembles very much the ticking of a watch under a pillow. In breech presentations it is usually heard a little higher.

This is a most valuable diagnostic sign, and if once heard, unequivocally, the real nature of the case is established beyond doubt.

The *placental souffle* may usually be detected by the stethoscope low on the sides of the abdomen, after the fourth month; it is a peculiar blowing sound, corresponding to the pulse of the mother.

The *movements of the child* may frequently be detected by placing a cold hand on the abdomen of the mother, after the sixth month, but this is not a certain sign, as above stated, since it may be imitated by movements of flatus, &c.

The following *resumé* of the signs of pregnancy is taken from the "Elements of the Principles and Practice of Midwifery," by Prof Tucker: —

DURING THE FIRST AND SECOND MONTHS.

RATIONAL SIGNS.

1. Suppression of the catamenial discharge.
2. Nausea, vomiting, ptyalism, anorexia, &c.
3. Unnatural flatness over the hypogastrium.
4. Tumefaction and tenderness of the mammæ.

SENSIBLE SIGNS.

1. Increase in the size and weight of the uterus.
2. Slight prolapsus of the uterus.
3. Diminished mobility of the uterus.
4. The cervix uteri is directed to wards the symphysis pubis.
5. The os uteri, round and regular in primiparæ, but in multiparæ, irregular in its circumference and more or less open.
6. Ramollissement of the mucous membrane, covering the cervix uteri. The fibres of the neck not yet softened.

DURING THE THIRD AND FOURTH MONTHS.

1. Suppression of the catamenia.
2. Continuance of nausea, vomiting, anorexia, ptyalism.
3. Slight prominence over hypogastrium.
4. Depression of the umbilicus.
5. Tumefaction of the breasts increased, with increase in the prominence of the nipple, and a slight discoloration of the areola.
6. Kiesteine in the urine.

1. The fundus uteri elevated rather above the pelvic brim, at the end of the third month. At the termination of the fourth month, it rises two inches above the pubis.
2. Fulness and dulness over the hypogastrium.
3. Existence of a small tumour in hypogastric region.
4. The direction of the long diameter of the uterus is now changed, so as to correspond with the axis of the pelvic brim. The os uteri is considerably elevated in the excavation.
5. Ramollissement of the inferior portion of the cervix is more marked; os uteri more open in multiparæ, but still closed in those who have not borne children.

DURING THE FIFTH AND SIXTH MONTHS.

1. Suppression of the catamenia.
2. Cessation of nausea, vomiting, &c., now usually takes place, though they may continue throughout pregnancy.
3. Increased prominence of the umbilical region.
4. The size of the abdominal tumour is increased, it is round, elastic, and if the abdominal walls be thin, the inequalities of the fœtus may be felt.
5. The umbilical region more full.

1. At the end of the fifth month, the fundus uteri is within an inch of the umbilicus.
2. Movement of the fœtus is now active.
3. The bruit de souffle and the fœtal pulsations may now be distinguished.
4. Ballottement.
5. Between the cervix and the pubis a tumour may now be felt, either soft and fluctuating, or round and hard.

RATIONAL SIGNS.

6. Discoloration of the areolæ more marked, with an enlargement of the subcutaneous glands.

7. Kiesteine in the urine.

SENSIBLE SIGNS.

6. Ramollissement of one half of the cervix uteri.

7. In primiparæ, the os uteri is still closed, but in multiparæ, it is sufficiently open to admit the half of the first phalangeal bone.

DURING THE SEVENTH AND EIGHTH MONTHS.

1. Suppression of the catamenia.
2. Nausea, vomiting, &c., ordinarily absent.
3. Abdominal tumour much increased in size.
4. Pouting of the navel.
5. Increased discoloration of the areolæ, with enlargement of the sebaceous follicles, and increased prominence of the nipple.
6. The milk may now be pressed from the swollen mammæ.
7. Kiesteine still exists in the urine.

1. Increase in the size of the abdomen.
2. The fundus uteri, at the end of the seventh month, has risen two and a half inches above the umbilicus; at the eighth, it is placed within the epigastric region.
3. Active movements of the fœtus.
4. The fœtal pulsations and the bruit de souffle still continue.
5. Ballottement perfectly felt during the seventh month, becomes obscure in the subsequent months of pregnancy, on account of the increase in the size of the fœtus.
6. The ramollissement of the cervix is more extensive, and at the end of the eighth month, is nearly complete.
7. In the primiparæ, the cervix is ovoid and somewhat shortened; the os uteri is still closed.
8. In the multiparæ, the os uteri is wide enough open to admit the whole of the first phalangeal bone; the upper orifice is firmly closed.

DURING THE FIRST HALF OF THE NINTH MONTH.

1. Reappearance of vomiting, not from nausea, but from pressure of the gravid uterus against the stomach.
2. The abdominal tumour is increased in size.
3. Respiration difficult.
4. All the other symptoms are augmented in intensity.

1. The fundus uteri occupies the epigastric region.
2. The movements of the fœtus; the pulsation of the fœtal heart are still present. At this time, ballottement has disappeared.
3. The whole cervix uteri is softened, except the internal orifice, which remains firm and closed. The os uteri in primiparæ is slightly opened, though not sufficiently to admit the finger, as is the case in multiparæ.

DURING THE LAST HALF OF THE NINTH MONTH.

1. The vomiting ceases, as the abdominal tumour sinks from the epigastrium.

1. The fundus uteri has sunk lower down in the abdomen.

RATIONAL SIGNS.	SENSIBLE SIGNS.
2. Respiration less oppressed.	2. The sensible signs still persist, except ballottement, which is usually, though not always, absent after the fœtus has acquired considerable size.
3. Considerable difficulty exists in walking, owing to the sinking of the presenting part into the pelvic excavation.	3. In multiparæ, the internal orifice of the cervix is softened and dilated so that the membranes may be felt. In primiparæ, the internal orifice is soft and dilated, but the external remains partially closed. During the last ten or twelve days, owing to the dilatation of the internal orifice of the cervix uteri, the whole cervix becomes enlarged, so as to increase the size of the uterine cavity; so that *in touching*, the finger reaches the membranes, in primiparæ, after having passed the thin and even margin of the os uteri, while in multiparæ, the external orifice of the cervix is thick and unequal.
4. Constant desire to evacuate the bladder and rectum.	
5. The hemorrhoids, the œdema of the limbs, and the varicose condition of the veins of the inferior extremities, are all increased.	

PREMATURE EXPULSION OF THE FŒTUS.

The uterus sometimes expels its contents before the full period of utero-gestation is accomplished. This may occur at any time during gestation, though it appears to be more easily excited at, or previous to, the third month, owing to the frailty of the connexion between the ovum and the decidua. It is also more liable to occur at the commencement of each menstrual return, than in the interval, owing to the increased excitement of the gestative organs at that time. It is called *abortion* when the fœtus is expelled before it is capable of maintaining an independent existence, that is, before the *seventh month.* It does sometimes happen that a fœtus lives when expelled before this time, but such cases are rare. The child is hardly considered "*viable*" before this time.

Premature labour signifies the expulsion of the ovum before the full term of pregnancy has expired, but after the *seventh month;* in other words, after the child has become viable.

Causes. — These are infinitely various and numerous, and include almost every agency capable of acting injuriously on the mother, and through her on the fœtus. Mental emotions, fright, anger, joy, or sorrow when excessive, intense pain, shocks, blows, falls, great fatigue, deficient nourishment, debilitating evacuations, acute and chronic disease, the exanthemata, syphilis, and the habits of life, either extreme, being capable of producing it. To these we may add a peculiar constitutional irritability of some females, by which they abort *habitually.*

Premature expulsion is sometimes produced by circumstances which compromise the life of the child. Thus, certain pathological con-

ditions of the amnion, chorion or decidua, malformations of the placenta, or erroneous insertion of the cord. Or it may occur from the administration of drugs exhibited for the purpose, or otherwise, such as ergot, savine, &c.

The manner in which these causes act, is either by destroying the child's life, in which method syncope, syphilis, and mercurial salivation seem to act; or by causing the womb to contract; or by partial separation of the placenta, causing the effusion of blood between that organ and the womb, and finally its entire separation, thus arresting the nutrition and respiration of the fœtus, and producing its death.

Symptoms. — The patient who is about to miscarry, generally experiences a sense of uneasiness, languor, pain in the back, and lower part of the abdomen, accompanied by pains of an expulsive character, and often with hemorrhage. When the ovum itself is ruptured, there is a discharge of water from the vagina, greater or less, according to the age of the fœtus, followed afterwards by pain and discharge of blood.

Sometimes the ovum is discharged with little or no pain, at others the pains are described as being more severe than those of labour at the full term.

Treatment. — There are two points to be observed in the treatment of these accidents: *first,* If possible, to prevent the expulsion of the fœtus, and enable the woman to complete her pregnancy; *secondly,* Where this is hopeless, to shorten the process as much as possible, and prevent further hemorrhage.

As we cannot be certain in the first instance, whether the child is dead, or not, it behooves us to act under the supposition of its life, knowing that if the vital relation between the ovum and the uterus is compromised it will be discharged.

The *preventive treatment* will consist in moderate bloodletting, if the patient be plethoric and the pulse full and bounding, rest in a strictly horizontal posture, on a hard bed, lightly covered with clothes, and in a cool room, cold wet napkins to the vulva, abstinence from stimulants, anodyne enemata, and if necessary, the internal use of astringents, such as infusion of rose leaves, elixir of vitriol, alum, acetate of lead and opium, &c.

If these means fail, and the hemorrhage continues, whilst the ovum is not expelled, there is little or no chance of preventing miscarriage; our endeavours must be directed to the suppression of the discharge, knowing it will generally cease as soon as the womb is emptied. The best agent we possess under these circumstances, is the *tampon,* or *plug.* This should never be used, however, if internal hemorrhage can take place to such an extent as to destroy life; in other words, not if the uterus be empty, and the patient far advanced in pregnancy. It may be used with safety and advantage, if the uterus be filled with its natural contents, or be only slightly distensible, even though empty. For this purpose some recommend a sponge steeped in vine-

gar, others a silk handkerchief, others, again, small, square pieces of linen pressed into the vagina till that cavity is entirely filled, the whole being retained in its place by a T bandage, or the hand of an assistant. It should be allowed to remain in situ, from six to twelve, or even twenty-four hours, the patient being still in a horizontal position, and the bladder, if necessary, relieved by the catheter. When withdrawn, the ovum, or fragments of it, will generally be found adherent to its upper part, along with a coagulum.

The tampon, it will be remembered, is not to be used under any circumstance where there is a hope of saving the pregnancy.

If the ovum is not discharged with the tampon, and cannot be reached with either the finger or hook, it is recommended to leave such occurrences in the hands of nature, rather than use force.

The *prophylactic treatment* consists in the avoidance of all causes of excitement, both mental and bodily. Small bleedings and rest if she be plethoric; a nutritious diet and tonics if otherwise, together with careful cold sponging. When the abortion is habitual, and the uterus is irritable, an efficient remedy has been found in the administration of an opiate enema every night, consisting of forty-five drops of tr. opii, in a wineglassful of starch water, rest, tonics, &c.

PATHOLOGY OF THE FŒTUS, AND SIGNS OF ITS DEATH.

The fœtus is liable to many of those diseases that attack the child after its birth. Many of these are entirely independent of the mother, but there are also many with which it is affected seriously through her. As examples of the latter may be classed those cases of premature expulsion which occur during the prevalence of epidemic diseases, and where the fœtus appears to have participated in the disease of the mother. Dr. Churchill has observed a considerable quickening of the action of the fœtal heart, some days after pregnant women have been attacked with fever. Examples are not wanting of cases where children have been born with small pox or measles; and according to Duettel, Schweig, Zurmeyer, &c., children born of mothers who were suffering under *intermittent fever*, have exhibited the same disease immediately after birth.

There is scarcely an internal organ that has not been described as the seat of inflammation; the brain and its membranes, the lungs and pleura, the peritoneum, the mucous membranes of the lungs and bowels, may all be the seat of inflammation during uterine life.

In addition to these acute diseases, the fœtus presents even more numerous cases of chronic affections; general hypertrophy, or atrophy, syphilitic diseases, worms, calculus, dropsy, jaundice, hernia, &c. Even the bones and joints may be the seat of disease; children are sometimes born with rickets, caries, and necrosis; and it has happened to many practitioners to meet with cases of fractures of some standing in children just born.

Unfortunately we possess neither the means of diagnosticating, nor of treating these cases of intra-uterine disease.

The signs of the death of the fœtus, are also obscure and uncertain. Absence of the sound of the fœtal heart is a negative sign, and its value will depend much upon the skill of the auscultator. If after repeated and careful auscultation of the abdomen no trace of fœtal pulsation can be detected, the death of the fœtus may be asserted on safe grounds. *Cessation of the movements of the fœtus* is no proof of its death, as the movements may be suspended for some days without its occurrence. The sensation of a weight in the abdomen rolling about as the woman moves, is, with some rare exceptions, a sure sign. The subsidence of the abdominal tumour, flaccidity of the breasts, after having been tense, and the general deterioration of the health, are all enumerated among the probable signs. The concurrence of all these render the diagnosis nearly certain, though separately they are of little value.

The signs during labour are much more accessible and certain. The loose, flabby scalp, the absence of swelling, occasionally emphysema of the cellular tissue beneath, the looseness and grating of the cranial bones, and the sharpness of their edges, are enumerated by Dr. Rigby among the certain signs. The absence of pulsations at the great fontanelles, is admitted to be an important sign.

In *presentations* of the *face*, the lips of a dead child will be flaccid and the tongue flabby and motionless, and the presenting part slightly swelled. The contrary in a living child.

In *breech presentations*, the sphincter ani in a dead child is relaxed and insensible to the finger. In a living child it is closed and resists the finger. The presence of meconium is a sign of no value.

In *arm presentations*, when the child is dead, the limb is cold, livid, and flabby, there is no pulsation at the wrist (the latter is not of much value, as pressure may arrest it), and the epidermis soon begins to peel off. In a living child, the arm will swell and become livid.

In *prolapsion of the funis*, the presence or absence of pulsation will decide. There are exceptions to this rule, however, as in the case related by Dr. Kennedy, in which the cord was prolapsed an hour, and during a pain no pulsation was perceptible; when the pain subsided he drew the funis backward towards the sacro-iliac symphysis, and then detected a faint pulsation. The child was delivered alive by the forceps.

Fetid liquor amnii is not a certain sign of the child's death, neither is the presence of meconium in it, especially in breech cases.

LABOUR.

By this term is understood, *that process by which the contents of the gravid womb are expelled.* It should commence as we have already seen, at or about the two hundred and eightieth day from the last ap-

pearance of the menses, or about one hundred and forty after quickening. The principal agent in effecting this process is the uterus itself, assisted, however, by the action of the diaphragm and abdominal muscles.

The *cause* of labour is not well understood: it has been variously attributed to the inability of the uterus to sustain farther distension, to the struggles of the fœtus in its endeavours to breathe, and to the absence of adequate nourishment. Whatever be the cause, certain it is that the fœtus contributes nothing to expediting the process, being entirely passive throughout, and the volition of the mother is but little concerned, farther than the assistance afforded by the voluntary contraction of the abdominal muscles and diaphragm, the action of the uterus being entirely involuntary. This action consists in the contraction of the muscular fibres, which enter into the composition of the uterine parietes. By this contraction the cavity of the uterus is diminished in size, propulsion is produced, and eventually expulsion is effected. The action of the uterus continues even after the child is expelled, for the purpose of extruding the placenta, and closing the orifices of bleeding vessels, which might otherwise give rise to serious hemorrhage.

The classification of labours. — Almost every obstetrical writer has a classification in accordance with his own peculiar views, each based upon his definition of a *natural labour.* Some include under the head of natural labour, all those cases which are terminated by the natural unassisted powers, without reference to the presentation. Among these are Hippocrates, Smellie, Baudelocque, Rigby, &c. Others consider that the presentation should be taken into account, and those only which occur most frequently should be called natural. Denman, Blundell, Davis, Ashwell, Ramsbotham, &c., therefore limit natural labours to head presentations.

The simplest classification seems to be that which includes *all* under two heads, viz.: *natural* and *preternatural. Natural labour*, or *Eutocia*, being that which follows a natural course, and in which the woman is delivered unassisted; *preternatural labour*, or *Dystocia*, signifying faulty or irregular labour, the course of which is unfavourable, and in which the assistance of the obstetrician becomes necessary.

The *general features* of labour are the same in every case, but the details are widely different. It is always attended with suffering, if the patient be conscious; and is sometimes complicated with irregularities and danger. The *duration* also varies much, as well as the amount of pain, in different women, and in the same women in different pregnancies, some expelling their children with a single pain, others requiring many to accomplish the same object.

The symptoms of labour may be divided into the *premonitory*, and those which indicate that the process has *already commenced.* The premonitory are, the subsidence of the abdominal tumour; some slight mucous discharge from the vagina, together with relaxation and dis-

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tensibility of it and the external parts; and a peculiar irritability and restlessness on the part of the patient.

The diminution of the abdominal tumour is produced partly by the subsidence of the uterus into the pelvic cavity, and partly perhaps by the painless contraction of the same organ. It is sometimes very sudden in its approach, the woman finding on rising from her bed that she is much less than on the preceding day. It is generally a good sign, as indicating that she has a roomy pelvis. The increased discharge and relaxation of the external organs is also a good sign, showing that there is a disposition in the passages to facilitate the progress of the labour.

The irritability and restlessness is seen also in the lower animals, and is therefore not peculiar to the human female.

The symptoms indicative of the *commencement* of labour are, pain, glairy discharge from the vagina, irritability of the bladder and rectum, nausea and vomiting, rigors or shivering, without the accompaniment of chilliness.

The *pain* felt in labour is due to the sensibility of the *resisting*, rather than to that of the *expelling* organs. The sharp, cutting pains of the commencement, which are technically termed *grinders*, are produced mainly by the stretching of the cervix uteri and the vagina, and are generally referred to the lower part of the abdomen and the back, in a position corresponding to the position of the os uteri. These generally accompany the dilatation of the os uteri, and are indicated by the cries and gestures of the patient, the former being of a moaning, complaining character, the latter, twisting and writhing.

When, however, the dilatation has gone to such an extent as to allow some of the contents of the uterus to be propelled through the opening, the pains become of a *forcing, expulsive* nature, and the gestures attending them differ from those before mentioned. The breath is held; she no longer cries out, but makes strong expulsive efforts as if straining at stool; she makes use of the muscles of respiration to fix the thorax, and then contracts the abdominal muscles upon the womb, at the same time pulling violently upon anything within her reach. The gestures and cries are valuable indications of the character of the pains. The characteristic of the uterine pains is, that they are dull, and not very acute in their character; are felt mainly in the back and loins; that under their action the uterus becomes *tight* and *hard;* and, particularly, that they are *regular* and *intermittent;* that is, coming on at tolerably equal intervals, and succeeded by an entire relief from suffering.

At the commencement, the uterine pains are short, weak, and at long intervals; as labour advances, the interval becomes less, and the pains longer and stronger. It is well known that labour pains may be suspended, by any sudden emotion, particularly those of a depressing character, as well as by opiates, administered either by the mouth, rectum, or rubbed upon the general surface.

The *mucous discharge* which takes place from the vaginal surface, is known commonly by the name of *show.* It is generally mixed with the gelatinous mucus that blocked up the uterine cervix, and with more or less blood. "The more albuminous it is, the better, and it is always a good sign when lumps of albuminous matter come away from time to time; the thicker, softer, and more cushiony the os uteri is, the more mucus does it secrete." It is useful not only as a lubricating agent, but also as a topical depletion, for by unloading the congested vessels, the vascularity and heat of the part are diminished, and rendered more capable of dilatation.

The *irritability of the bladder* and *rectum* are among the most prominent signs of commencing labour, and are dependent upon the contiguity between the dilating os uteri and these organs, which all derive a portion of their nervous influence from the same source. The disposition to urinate exists even when the bladder is empty, and the tenesmic irritability of the rectum is equally independent of the presence of fæcal matter.

Nausea and *Vomiting*, at the commencement of labour, are looked upon as favourable signs, being indicative of a general relaxation, which favours the dilatation of the os uteri. It must not, however, be confounded with that which sometimes supervenes in lingering labours, which is rather prognostic of great exhaustion, and to be dreaded accordingly. In ordinary cases, vomiting in the early stages requires no treatment, being generally relieved as soon as dilatation takes place. When, however, it is very violent, it may often be checked by an effervescing draught, with a few drops of laudanum. The *rigors*, which often occur early in labour, are likewise accompaniments of the dilating os uteri, and although often severe, are not dependent on diminished temperature of the female, or irregular arterial action; they require little other treatment than an extra covering, and diluent drinks.

STAGES OF LABOUR.

Some obstetricians divide a labour into three, others into four, five, or six stages, all ending with the expulsion of the placenta. The first division is the one generally adopted, and the three stages are thus enumerated. The first terminates with the dilatation of the os uteri; the second with the delivery of the child; and the third with the expulsion of the placenta.

First stage.—This is generally the longest and most distressing, both to practitioner and patient. The pain, although not so great as in the second stage, is of a more distressing character, and more difficult to bear. The patient is more irritable, uneasy, and alarmed as to the result. The character of the cry, as before mentioned, as well as the gestures, are peculiar to this stage, as well as diagnostic of it. Nausea and vomiting also occur during this stage, and, it is thought, assist in effecting it.

By placing the hand upon the abdomen during a pain, the uterus can be felt to contract and harden itself, and at the same time to tilt forwards so as to bring its axis into accordance with that of the superior strait. As the pain goes off, the uterus becomes soft again, without, however, returning to its former state of relaxation.

The approach of a pain may often be foretold by the practitioner before its access, by auscultation. "The moment a pain begins, and before the patient is herself aware of it, we hear a short rushing sound, which appears to proceed from the liquor amnii, and to be partly produced by the movement of the child, which seems to anticipate the coming on of the contraction; nearly at the same moment all the tones of the uterine pulsations become stronger; other tones which have not been heard before, and which are of a piping, resonant character, now become audible, and seem to vibrate through the stethoscope, like the sound of a string which has been struck and drawn tighter, while in the act of vibrating."[1] As the pain grows stronger, the pitch rises. By the time the pain has reached its height, the sound has entirely ceased, or become very faint; as it departs, however, the sound again returns as at the beginning of the pain, and finally resumes its former tone, which it had during pregnancy. The noise made by the escape of the blood through the uterine veins during a contraction, is probably an important element in the production of the sound in question.

It is remarked also by the author quoted above, that the pulse increases in rapidity in proportion as the pain rises in intensity, subsiding in the same manner with it. As the labour advances, the rapidity of the pulse increases, so that shortly before the child is born, it has attained the maximum that it had during the height of the pains in the commencement.

A per vaginam examination at the commencement of labour reveals to us the condition of the parts through which the child is about to pass. If the vagina is cool, moist, and cushiony, and the os uteri soft and thick, the dilatation will most probably proceed favourably. If, on the contrary, the vagina is hot and dry, and the os uteri hard and thin, or hard and thick, the first stage will generally be tedious. *The time occupied in the first stage* varies very much in different women, and in the same women in different labours. In primiparæ, it is generally longer than in those who have had several children. Regular and genuine contractions seldom require more than eight to ten hours to perfect this stage, and often it is accomplished in much less. The dilatation also proceeds much more slowly at the commencement, than it does later; this is owing to the want of the mechanical dilatation which it afterwards receives by the formation of the bag of waters, which acts as a wedge, and forcibly distends the os uteri.

Bag of waters.—As the circle of the os uteri enlarges, the mem-

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[1] Rigby p. 159.

branes of the ovum, containing a portion of the liquor amnii, protrude through the opening, forming a tense, elastic, conical bag; this by its mechanical pressure assists in the dilatation of the os uteri. During a pain it can be felt becoming more and more tense, and again relaxing as the pain subsides, so that the presenting part can often be detected through it.

Near the end of the first stage streaks of blood will often be found mixed with the mucus upon the finger, after an examination. This is commonly denominated in the lying-in-rooms "*a show*," and it is usually an indication that the os uteri is dilated, or nearly so. The hemorrhage proceeds from the slight vascular twigs extending between the uterus and the membranes, which are ruptured by the increasing dilatation.

The phenomena which have been described are repeated during every succeeding pain (the intervals being shorter and the pains longer), until the dilatation of the os uteri is completed. During the whole period of the first stage, the pains have been acting, not so much for the expulsion of the child, as for preparing it and the passage for that purpose. The more completely the os uteri is opposite to the fundus, and the greater the correspondence between the axis of the uterus and that of the superior strait, the more speedily will the dilatation be accomplished. As soon as this has taken place, the first stage is ended.

Second stage.—The phenomena that present themselves in this stage differ essentially from those of the preceding. The pains succeed each other with greater frequency, and last longer, and the suffering is increased; but, in consequence of the respiratory muscles being fixed, in order to supply a fulcrum for muscular exertion, the woman rarely cries out during a pain. Hence the character of the cry, as before stated, is a diagnostic sign of this stage. The pains now appear not to be so much confined to the womb; they acquire a more *expulsive* character, and are attended with strong bearing-down efforts of the abdominal muscles. Upon the approach of each pain, the woman seizes hold of anything within her reach, and brings the muscles of the extremities, back, and abdomen to aid her in the effort. These are commonly called *bearing-down pains.* If the membranes have not ruptured previously, they generally give way during one of these pains, and the liquor amnii escapes through the external organs; the fœtus forced downwards by the same contraction, immediately fills up the space previously occupied by the bag of waters, and the uterus condenses itself upon the body of the child, which is therefore folded into a smaller space, and is much more compressed than previously.

Each succeeding contraction pushes on the presenting part; but, as the pain goes off, it again recedes, not, however, to the point it occupied before, as there generally is more or less advance on that gained by the preceding effort. If it were not for this gradual advance and recession, there would be greater danger of laceration of the soft

parts, from a continued expulsive effort before the passages were sufficiently dilated to receive the presenting parts. It thus not only takes away the danger of pressure, but is in itself a good sign, inasmuch as it proves that the cavity of the pelvis is sufficiently capacious. The woman during the second stage is much less irritable than in the first. She seems to have recovered her energy and equanimity, and, if this stage be prolonged, will often sleep between the pains. The young practitioner should be on his guard, however, in relation to this drowsiness, particularly if it occur in primiparæ, and be much protracted, or accompanied with headache, as it is indicative of congestion, and may be the precursor of convulsions.

During the descent of the presenting part, particularly if it be the head, we are often informed of its progress by the occurrence of an unpleasant symptom, viz., cramp in the lower extremities, produced by pressure upon the internal sacral nerves. Under the influence of another pain the head descends along the vagina, and begins to press upon the perineum, the rectum becomes flattened, and its contents are involuntarily expelled; by the time it has reached the floor of the pelvis it is about to meet with its greatest resistance, viz., that of the perineum. Here again we observe the gradual advance and recession, until this part is distended to such a degree as to allow the presentation to escape over it. This distension is often so great, and the perineum so thin, that the finger can scarcely distinguish it from the presenting part. Occasionally it happens that from this cause the part is rendered transparent, so that the presentation is visible through it. Twice Madame Lachapelle has seen the hair of the fœtal head through the distended perineum (Fig. 295). The presenting part has now entered the inferior strait, the coccyx is pushed backwards, and the external orifice is dilated; the anus projects, and the whole perineum is elongated; the labia majora, and even the mons veneris, are put greatly upon the stretch, and the former disappear entirely; this is not the case, however, with the labia minora, which can be felt even at the moment of the exit, and greatest distension. The sufferings of the patient are now at their height, and the pains are frequently "*double*," a new one commencing before the former has quite terminated. The force is at length so great, that all resistance is overcome, and with a cry of anguish the exit is effected. There generally succeeds an interval of rest for a few seconds or more, then the pains again return, and the remainder of the child is expelled.

The second stage is now completed, and the woman is entirely free from pain. If the hand be placed upon the abdomen, it will be found flabby and relaxed, and the uterus can be felt through the abdominal parietes, large, and moderately contracted.

The third stage is occupied by the detachment and expulsion of the placenta; the period occupied in effecting this varies much in duration. Sometimes it is expelled with the body of the child; at others, it is retained for some time after. Usually, after an interval of ten or fifteen

Fig. 295.

minutes, pains of a different character follow; by these the detachment of the placenta is effected, and it is extruded into the vagina. By the voluntary efforts of the woman, assisted by the contraction of the vagina, it is entirely expelled, and the *labour* is completed. Its expulsion is commonly accompanied by a gush of blood, from which circumstance these pains have been called *dolores cruenti.*

The placenta generally enters the vagina inverted, that is, with its fœtal face looking outwards, and the bag of membranes is also turned inside out. Especially is this the case, if traction has been employed upon the cord. After the expulsion, the uterus, now emptied of its contents, contracts into a firm hard ball, which can usually be detected for some days above the symphysis pubis. In this state of condensation it is about the size of a fœtal head.

PRESENTATIONS AND POSITIONS.

By the term *presentation,* we understand that part of the child which offers itself at the superior strait. By *position,* the relative situation of the presenting part to some cardinal point of the superior strait.

It will at once be seen that there may be a presentation for every square inch of the child's body, and a position for every degree in the circle of the superior strait. This, however, would lead to endless confusion; hence obstetrical writers have diminished the number greatly. Some make only *two* great presentations, viz., of the *head* and *breech,* looking upon all others as deviations from one of these. Others include the above with their deviations, viz.: —

Cephalic presentations, including any part of the head. *Breech or pelvic*, including the hips and loins. *Inferior extremities*, including the knees and feet. *Superior extremities*, including the shoulder, elbow and hand.	Churchill.

Others, such as the back, belly, and sides, are so exceedingly rare, that it is not considered advisable to burden the student's mind with them, particularly as their treatment is the same as that of shoulder presentations.

The *diagnosis* of these different presentations may be described in general terms, as follows, viz.:

Of the *head*, by its hardness, by the presence of sutures and fontanelles, and by its shape.

Of the top or *Bregma*, by the shape of the anterior fontanelle.

Of the *face*, by its irregular shape, by the orbits of the eyes, by the nose, mouth, &c.

Of the brow, or forehead, by its shape, by the superciliary ridges, and by the anterior fontanelle.

Of the *breech*, by its softness, by the nates, organs of generation, tubera ischii, and often by the meconium, by the *single* prominence of the os coccygis, and by the sphincter ani muscle, which contracts when irritated by the finger.

Of the *knee*, by its rounded form, and by the condyles of the femur, and perhaps by the patella.

Of the *foot*, by its length, shape, position at right angles to the leg, by the equal length of the toes, the heel, &c.

Of the *shoulder*, by its rounded shape, by the clavicle, the spine of the scapula, the axilla, ribs, &c.

Of the *elbow*, by its sharpness, produced by the olecranon process.

Of the *hand*, by its shortness, the thumb and fingers, palmar and dorsal aspect, &c.

In regard to the *positions*, it is customary to note the relation between some point of the presenting part, and some other point in the brim of the pelvis; for instance, the first position of the vertex is that in which the posterior fontanelle is found behind the left acetabulum. The different positions will be spoken of in treating of the various presentations.

MECHANISM OF LABOUR.

"When the long axis of the child's body corresponds with that of the uterus, the child (provided the passages are round) can be born in that position; it matters little, so far as the labour is concerned, which extremity of the child presents, so long as this is the case; but where the long axis of the body does not correspond with that of the uterus, the child must evidently lie more or less across, and will present, with the arm or shoulder, a position in which it cannot be born. In stating this, we wish it to be understood, that we merely refer to the full-

grown living fœtus, and not to one which is premature, or which has been some time dead in the uterus, as these follow no rule whatever. Hence the positions of the child, at the commencement of labour, resolve themselves into two divisions, viz., where the median line of the child's body is parallel with that of the uterus, and where it is not." — *Rigby*.

Vertex presentations.—The vertex may present at the brim of the pelvis in various positions; some obstetrical writers enumerate as many as eight, others only four, whilst a third class take the intermediate number of six. The latter is the division of Baudelocque, and the one most generally adopted in the schools. These are as follows, enumerated in the order of their most frequent occurrence.

1st.	Occiput at the	left acetabulum;	Bregma at the	right sacro-iliac	junction.
2d.	"	right "	"	left "	"
3d.	"	symphysis pubis,	"	promontory of the sacrum.	
4th.	"	right sacro-iliac junction	"	left acetabulum.	
5th.	"	left " "	"	right "	
6th.	"	promontory of sacrum,	"	symphysis pubis.	

Naegelé and others make four, leaving out the fifth and sixth. Rigby makes only two, viz., the first and second, whilst Ramsbotham, Flamant, &c., make eight, adding to those already enumerated, 1st, the face inclining to the right ilium, the occiput to the left, the right ear behind the symphysis pubis, the left towards the spinal column. 2d, the reverse of the first, face to the left ilium, occiput to the right, right ear towards the promontory of sacrum, left behind symphysis pubis. The remaining six follow in the order given above.

According to the table given above, the first three are called *occipito-anterior*, the last three *occipito-posterior*.

In regard to the *frequency* of these positions, it may be stated that Naegelé maintains that the *fourth* position of the vertex is much more common than the second, and that the fifth and sixth are so rare that they are discarded entirely by many eminent practitioners, they having never met with them.

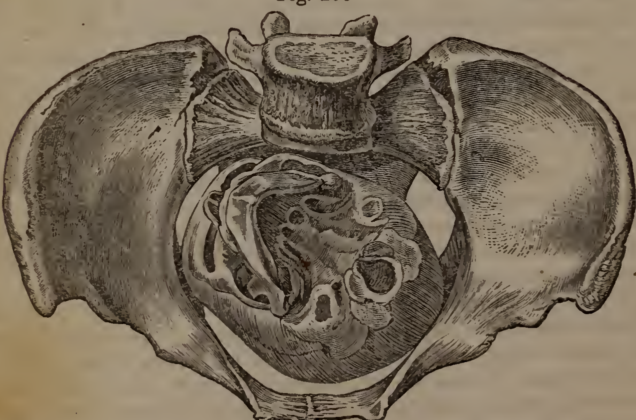
Cephalic presentations are by far the most numerous of the varieties that offer themselves, and of these, those of the vertex in the first position occur most frequently. Madame Boivin states, that in supervising twenty-thousand five hundred and seventeen labours at the Maternité Lying-in Hospital, at Paris, she found fifteen thousand six hundred and ninety-three cases in which the vertex presented in the first position.

The greater frequency of vertex presentations may be readily accounted for. It will be remembered that the fœtus hangs suspended in the liquor amnii by the umbilical cord, which is attached nearer to its pelvis than its cephalic extremity; the head being the heaviest part, consequently becomes the most dependent.

Neither is it difficult to explain why the head in labour more commonly presents itself in the occipito-anterior, rather than in the con-

trary way. The child in utero naturally lies on its back, with the head inclined downwards towards the orifice of the womb. The long diameter of the womb, at the end of pregnancy, and especially at the commencement of labour, dips at an angle of about forty-five degrees towards the horizon in a woman, who is sitting or standing up. The child being in a complete state of flexion both as to its body and limbs, would naturally roll, so as to bring that part of its body which is convex, to adapt itself to the concavity of the womb. This will of course be its back. The uterus at the same time rests upon the abdominal muscles anteriorly, which form a soft cushion for it. The head can only pass the brim of the pelvis (superior strait), by the adaptation of certain of its diameters to those of the pelvis. The longitudinal diameter of the child's head is four and a half inches, whilst the antero-posterior diameter of the superior strait is only four: it must therefore adapt itself either to the oblique or the transverse; of these, the oblique is most common. Suppose it to be a first position, in which the longitudinal diameter corresponds with the oblique of the superior strait, the vertex is behind the left acetabulum, and the forehead at the right sacro-iliac junctions. The two fontanelles will be at first on a level.

Fig. 296



The first step in the mechanism of labour is the *flexion of the head*, or the approach of the chin to the breast. This is produced by the action of the uterus pressing the head downwards into the cavity. Being pressed from above downwards, the spine causes the head to bend forwards, so that the occiput sinks towards the centre of the pelvis, and the chin is squeezed firmly against the breast.

By this movement, the diameters of the child's head are brought into correspondence with such diameters of the pelvis as will allow its ready transmission. The occiput occupies the centre of the supe-

rior strait; the occipito-bregmatic diameter corresponds to the oblique diameter of the pelvis, which extends from left to right, and from before backwards; the bi-parietal represents the other oblique diameter; the occipito-mental is parallel to the axis of the pelvic circle, and the occipito-bregmatic circumference corresponds to the plane of the strait.

Next follows *rotation,* by which is meant, the screw-like movement of the head in the excavation, by which the vertex is brought to the symphysis pubis.

By the continued action of the uterus, the head is pushed into the excavation until it reaches the floor of that cavity; here its progress is arrested and the direction changed by the gliding of the occiput upon the left anterior inclined plane, from behind forwards and from left to right, so as to place itself behind the symphysis pubis. Whilst the vertex is executing this movement, the forehead glides from right to left, and from before backwards, on the right posterior inclined plane, so as to fall into the hollow of the sacrum. In executing this rotation, or pivot motion, the head turns upon its long diameter.

The third stage is *extension*, which signifies the departure of the chin from the breast.

This commences as soon as the occiput begins to emerge, and is completed when the child's head is entirely born. Instead of continuing to bend forwards, the head now tends to turn over backwards, so as to bring the occipito-mental diameter into correspondence with the axis of the inferior strait.

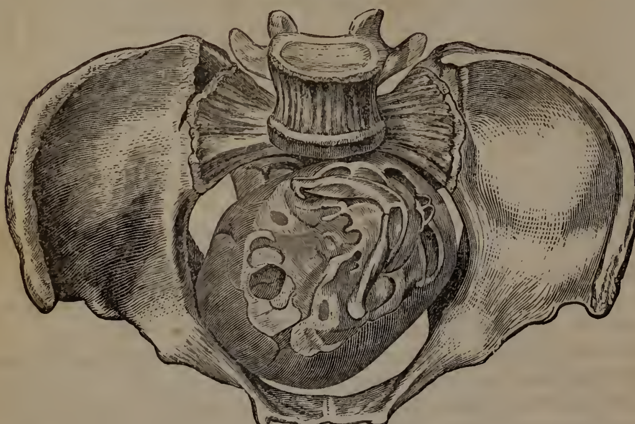
After the head is fairly engaged in the inferior strait, it is no longer in the same relation to the diameter as before; its great diameter and occipito-bregmatic circumference, however, have not undergone any change, for we find, that at the inferior strait, as well as at the superior, they still represent the plane and axis of that strait. The bi-parietal diameter corresponds to the transverse of the inferior strait, and the occipito-bregmatic to the antero-posterior. The great end of *rotation* is to produce this relation between the diameters, to effect the exit of the child's head.

The last stage is *restitution*, by which is meant, the turning of the vertex again to that side of the pelvis, towards which it was directed before the labour began, or before rotation took place. As soon as the head is born, all restraint is taken away from it, and as it is incapable of retaining the twist which brought it under the arch of the pubis, it returns to its natural position upon the shoulders, which had been temporarily changed. In the position now under consideration, the vertex turns towards the left thigh of the mother, and the chin to the right. A short interval of ease succeeds the birth of the head, after which the shoulders enter the excavation. They also enter obliquely, and perform the rotation as above described. The right shoulder is behind the right acetabulum, and rotates from right to left on the right anterior inclined plane towards the symphysis pubis; the

left is at the left sacro-iliac junction, and rotates from left to right on the left posterior inclined plane into the hollow of the sacrum. The right shoulder generally appears first at the pubic arch, whilst the left escapes over the perineum; the vertical axis of the child's body is bent, so as to accommodate itself to the axis of the pelvis, which, it will be remembered, is a curved line. After the shoulders emerge, the rest of the body is expelled without anything peculiar to demand description.

In the *second position* of the vertex, the mechanism differs but

Fig. 297.



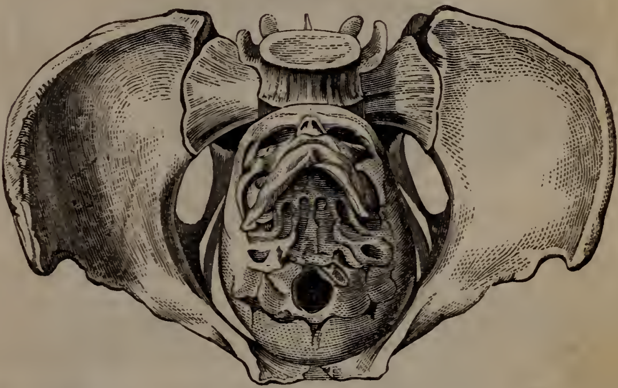
little from that of the first; the same forces are brought to bear upon the child, and the same diameters offer themselves to the principal diameters of the pelvis; the head also executes the same movements as in the preceding. The vertex, however, in this case, is behind the right acetabulum, and rotates from right to left on the right anterior inclined plane, and the forehead on the left posterior inclined plane into the hollow of the sacrum. At the inferior strait there is no difference between the two positions; but after the escape of the head, the vertex turns towards the *right thigh*, the left shoulder comes under the arch of the pubis, and the right falls into the hollow of the sacrum; but in these changes there is no variation from the proportional relations between the fœtal head and the maternal pelvis.

This is considered by some obstetricians as not so favourable a position as the first, in consequence of the impediment offered by the rectum to the rotation; this is not believed to be a valid objection, as the rectum can be easily emptied, and then offers but a slight obstacle.

The *third position* is confessedly so rare that some obstetrical

writers have banished it entirely. Baudelocque admitted it rather to fill up his plan, than from any evidence of his senses. Madame Boivin met with it only six times in twenty thousand five hundred and seventeen cases. Velpeau is also sceptical as to its existence.

Fig. 298.



When it does occur its mechanism is a little different from the preceding; the occiput is at the pubis, and the forehead at the promontory of the sacrum. In this case, the occipito-mental diameter corresponds with the axis of the superior strait, and the occipito-bregmatic circumference with the plane of that strait.

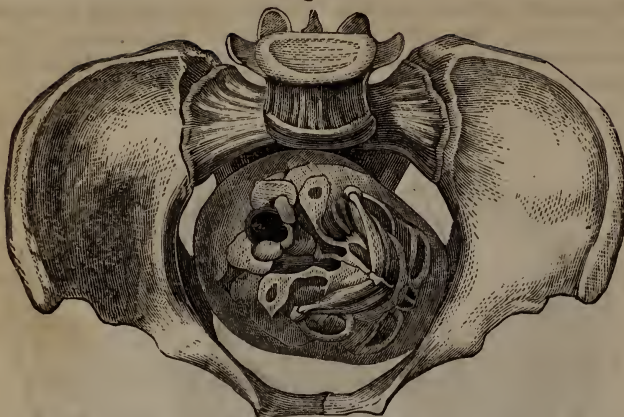
The bi-parietal diameter, however, is situated transversely, and the occipito-bregmatic from front to rear. There is no rotation necessary in this case, and none occurs, consequently there is no restitution.

The shoulders commonly enter transversely, although they generally emerge with one at the sacrum and the other at the pubis, without our being able to tell beforehand which it will be. In the rest of the labour there is nothing peculiar.

The *fourth position* of the vertex is the most common of the occipito-posterior varieties. In this position the same diameters correspond as in the first; but, the situation of their extremities is reversed. Engagement takes place more easily, and the head descends into the excavation more readily than in the occipito-anterior positions, until it reaches the floor of the pelvis. Instead of extension occurring readily now, a greater degree of flexion is demanded, so as to enable the occiput to rotate into the hollow of the sacrum, which it does, from right to left, upon the right posterior inclined plane, whilst the forehead, or anterior fontanelle, slides forward upon the left anterior inclined plane, from left to right.

The vertex is born first, over the perineum, and extension takes place backwards, so that the posterior fontanelle, the sagittal suture,

Fig. 299.



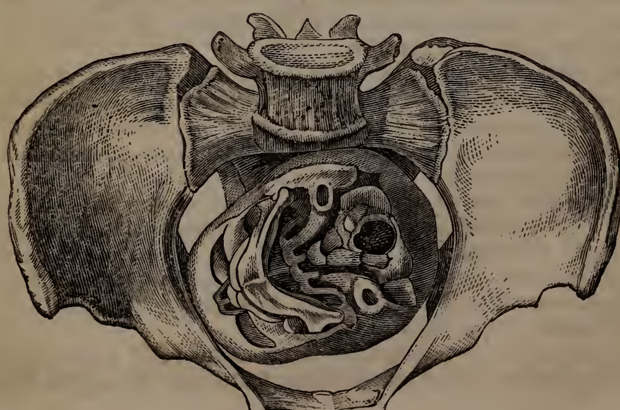
the anterior fontanelle, the parietal protuberances, and the several parts of the face, are successively seen in front of the perineum. Immediately after the birth of the chin, restitution takes place; the face turns towards the left groin, and the occiput towards the posterior part of the right thigh of the mother.

The left shoulder rotates to the front under the symphysis pubis, while the right falls into the hollow of the sacrum.

M. Naegelé states that this position is more common than the second, and that rotation takes place from behind forwards, so as to bring the occiput under the pubes, instead of into the hollow of the sacrum, as already described. In this opinion he is confirmed by Professor Meigs.

In the *fifth position*, the back of the child is directed to the left

Fig. 300.



and backwards, the right shoulder to the left and forwards, and the left, to the right and backwards; the bi-parietal diameter corresponds with the left antero-posterior oblique, and the occipito-bregmatic with the right antero-posterior oblique diameter; the lesser circumference of the fœtal head, and the occipito-mental diameter, are parallel with the plane and axis of the strait. Rotation of the vertex takes place upon the left posterior inclined plane, into the hollow of the sacrum, while the forehead, gliding upon the right anterior inclined plane, is brought to the symphysis pubis.

After the birth of the head, *restitution* takes place, with the occiput to the inside of the mother's left thigh, while the face looks towards the right. This is said to be a more difficult position than the preceding, in consequence of the presence of the rectum, which retards the progress of the occiput.

In the *sixth position*, as in the third, there is neither rotation, nor

Fig. 301.

restitution; the occipito-bregmatic diameter corresponds with the antero-posterior, and the bi-parietal with the transverse.

It is less favourable than the corresponding oblique positions, in consequence of the liability of the forehead and face to be turned downwards, and thus permit the long diameter of the head to be brought into paralelism with the short diameter of the pelvis.

In all these occipito-posterior positions, there is much greater distension of the perineum than in the occipito-anterior, in consequence of the head having to descend lower; they are therefore more tedious and painful.

It is by no means an easy matter to diagnosticate the *positions* of the vertex; it requires great delicacy of touch, and considerable experience. The movements of the child, and the stethoscope, are valuable assistants to the sense of touch. Naegelé observes that when the

movements are felt most on the right side, the head is probably in the *first* position, when on the left, in the *second*.

The stethoscope also informs us of the situation of the fœtal heart, and when this is decidedly known, it becomes an easy matter to define the position of the head.

CONDUCT OF A LABOUR.

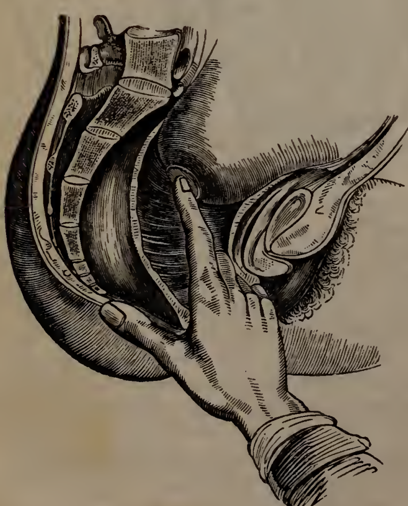
The conduct of a labour includes all that is done for a parturient patient from the beginning of her pains till the uterus is emptied, and the safety of both mother and child secured. It is not to be understood by this, that the accoucheur is to substitute himself for nature; on the contrary, he really has little to do in most cases, expect to receive and protect the child, to deliver the placenta, and watch over the mother and her offspring for some hours after the delivery.

Whilst thus he is ready to let nature assist herself, he must be prompt to recognise and avert any danger that may arise.

It is well for the practitioner always to be provided with a lancet and an elastic male catheter; and if he live in the country, with a little laudanum. The first duty of the attendant is, to ascertain *her present condition, whether in labour or not*, and if so, *how long she has been in labour, the nature of the presentation, the rate of progress, and probable termination.*

The first conditions will be readily discovered, by examining the skin, pulse, tongue, &c.; then directing the attention to the pains, noting their character, frequency, duration, &c., the character of the outcry, the gestures of the patient, and the state of vaginal discharge. By these symptoms he will be enabled to judge of the existence of labour or not, the stage and rate of progress, and also of the necessity for a more particular examination.

Fig. 302.



One of the first duties of the practitioner, after the above inquiries have been attended to, is to discover the condition of things by a per vaginam examination; this, it need hardly be said, should always be proposed in the most

delicate manner. There is much information to be gained during the first examination (and it should *never* be *needlessly* repeated; first, whether she be really pregnant; secondly, if she be in labour; thirdly, whether the membranes have ruptured or not; fourthly, the nature of the presentation; fifthly, the stage and progress of the labour; sixthly, the state of the os uteri, vagina, and perineum; he is also to take the opportunity of estimating the capacity of the pelvis, and other circumstances which may influence the duration of the labour. (Fig. 302.)

It is scarcely necessary to repeat this examination during the first stage, if all is right; but in the second, it should be regulated by the rapidity of the advance, and when once the head has reached the perineum, the finger should be kept upon the head during each pain, so as to regulate the amount of support for the perineum. The finger ought always to be introduced *during* a pain, but the examination should also extend to the *interval*.

During the first stage, the patient need not be confined to the bed, but may be allowed to sit up, or even to walk about, if she desire it. Neither is it incumbent upon the medical attendant to remain in the lying-in-room during the first stage; his presence may be a restraint upon the patient.

The condition of the bowels should always be early attended to, and if they have not been acted upon lately, should be unloaded either by an enema, or an aperient. The bladder should also be emptied, either spontaneously, or by the catheter. The diet of the patient, when the first stage is protracted, should be of a light, unstimulating character; the object being to sustain nature while under a severe effort, at the same time that we carefully avoid calling that effort in the direction of the digestive organs.

There should always be in readiness several strong ligatures for the cord, a pair of sharp scissors, some strong pins, and a "binder," or broad bandage for the female. It is likewise the duty of the accoucheur to see that the bed is properly prepared for the patient. This is best done by spreading a piece of oiled cloth upon the mattress to protect it at the point the patient is about to occupy; over this may be placed several blankets or coverlets, folded square, to receive the discharges, &c. These latter can be easily removed after the labour is completed, without disturbing the patient, leaving the bed-linen beneath unsoiled.

The *second stage* is often announced by the rupture of the membranes. As soon as this occurs the patient should retire to her bed, and the practitioner make an examination, in order to determine more accurately the position, and inform himself of the advance of the head.

In this country and in England, it is usual to place the woman upon her left side, with her hips close to the edge of the bed, and her knees drawn up towards the abdomen. The position enables the prac-

titioner to use his right hand with advantage, and is also supposed to favour the engagement of the head in the first position. If the membranes have not ruptured at the commencement of this stage, and the head has passed the circle of the os uteri, they may be broken either by pressing the finger upon them during a pain, or by means of a probe passed along the index finger, provided always, that it is not a first labour, and the attendant is satisfied that their usefulness as a dilating agent is at end.

When the head has reached the floor of the pelvis, and is beginning to distend the perineum, the latter should be supported by the palm of the left hand (guarded with a soft napkin), in such a way as to delay the passage of the head slightly, and to bear it towards the pubis, so as to prolong the curve of the sacrum, and make certain of the head being carried forward to the anterior orifice of the vagina, and not allowed to perforate the perineum for want of a just support.

As the head escapes from the os externum, it should be received in the hand of the practitioner, and allowed to perform the motions of restitution, carrying it forward as the shoulders are expelled; he should also be careful to observe whether the cord is twisted about the neck, and if it be to disengage it. The perineum should be supported during the exit of the shoulders, and the whole body carried forward in the axis of the pelvic outlet, and not by any means *pulled out*, in order to relieve the woman from pain, and facilitate the delivery.

When the child is entirely born, and respiration is established, or the cord has ceased to pulsate, it may be separated from the mother. To do this, one strong ligature should be tightly tied around the cord about two inches from the umbilicus, and another about an inch further on, and the cord cut between them. The two ligatures are useful in case of twins, which sometimes have a common placenta, and also for the sake of cleanliness.

The accoucheur should then place his hand on the abdomen of the mother, for the purpose of ascertaining whether there be a second child or not, and also to discover, from the state of contraction of the uterus, whether the placenta be discharged or not.

If the uterus be well contracted, the placenta will probably be found in the vagina; as soon as it has descended so low that he can feel the insertion of the cord, he may withdraw it by gentle traction in the axis of the vagina. No force should be used in this operation, for fear lest the placenta should be still adherent, and thus the risk of inversion be produced, or the cord torn from its insertion. The pudendum should now be carefully and gently dried, and covered with warm napkins; after which the binder should be so applied as to extend from the pubes to the ensiform cartilage, and drawn moderately tight, thus affording an adequate support for the uterus and abdominal viscera.

The wet sheets, &c., may now be removed from under her, and the

patient covered over to prevent chilliness, and then left to have an hour's rest before she is made comfortable in bed.

The child should be put to the breast as soon as the mother is sufficiently rested. It is not only useful to the child by supplying it with the early secretion, which is laxative, but it is also beneficial to the mother, inasmuch as it excites contraction of the uterus.

The diet of a woman lately delivered should be as light as possible, consisting mainly of the farinaceous articles; and she should be kept in a strictly horizontal position till all danger of hemorrhage has passed.

About a half an hour after the labour is completed there often occur a succession of painful contractions called *after-pains.* During their presence, the discharge from the uterus increases and coagula are frequently expelled; their operation is salutary within certain limits, they prevent hemorrhage, diminish the size of the uterus and expel its contents; they are rare in primiparous women. If very severe they may be diminished by small doses of camphor and opium.

The *lochia* is the name given to the discharge that continues after labour is completed. For some days it retains the character of blood; but it finally loses its firmer portions and red globules, in consequence of the continued contractions of the uterus, and becomes of a greenish tint. It comes from the patulous orifices of the vessels on the uterine surface where the placenta was attached, and disappears as these become compressed by the uterine contractions. It usually lasts three weeks, though sometimes longer.

General directions have been given for the management of the child after birth; it sometimes happens that it requires further attention at the hands of the practitioner, owing to some pathological condition into which it may have fallen. For instance, when born it may be in a state of *defective vitality*, *asphyxia*, or *apoplexy*. The first condition may be produced by excessive uterine hemorrhage, by too early a detachment of the placenta, or by defective nutrition. This will be recognised by the feeble efforts at respiration, and the weak and irregular action of the heart. Under these circumstances no advantage is gained in preserving the connexion between the mother and child; the cord should be tied and cut, and the infant immersed in a warm bath of the temperature of 97° or 98° Fahr. If after a few minutes, the child does not gasp, and we observe that the heart is acting less forcibly, a longer continuance in the bath will do harm; it should, therefore, be removed, and cold sprinkling tried, or what is better, gentle stimulation by means of frictions over the general surface, and, if necessary, artificial respiration.

In the *second condition*, the child is sometimes asphyxiated by pressure upon the cord, or by being delayed in the passage in a tedious labour. Here it would be obviously improper to cut the cord; the practitioner should resort to frictions, cold aspersions, or water poured from a height upon the epigastric region, artificial respiration, &c.

Should these means fail, he may try the effect of bleeding, by cutting the cord and allowing about a table-spoonful of blood to escape; if this is unsuccessful, the case is probably hopeless.

The *third condition* is most frequently produced by long-continued pressure, or, from an interval elapsing between the birth of the head and that of the body. Under these circumstances, the action of the heart is weak, and the pulsation in the cord feeble and oppressed, the surface is blue, and the face livid; and, occasionally, it happens that the form of the head is altered. Bloodletting is here obviously indicated, and it should be done by cutting the cord and allowing from half an ounce to an ounce to escape; when it will generally be found, that the surface becomes of a natural hue, the pulse quicker and firmer, and an attempt is made to respire. If the child does not breathe, a sudden puff into its face, or a slap upon the buttocks, will often establish respiration, or the means above-mentioned may be resorted to.

The tumour that is often found upon the scalp of new-born children, called *caput succedaneum*, and which is produced by the extravasation of blood, or effusion of serum beneath it, generally disappears spontaneously, or by the application of spirit or some stimulating lotion.

Hemorrhage from the navel after the separation of the cord is sometimes very troublesome, and may be treated by means of astringents, cautery, compresses, &c.; if these means fail, Dr. Churchill recommends to stretch open the navel and fill it with plaster of Paris, either dry or moistened, allowing it to remain till solid. Others propose to cut down upon the vessel and tie it. A less formidable operation has been successfully practised in this city, by the late Dr. J. M. Wallace, by passing two needles through the navel parallel with the surface of the abdomen, and at right angles to each other, and applying a ligature beneath them, as in the operation for aneurism by anastomosis.

TEDIOUS LABOUR.

The labour is often prolonged beyond the usual limit by a delay in one of the three stages, and yet may be completed without either manual or instrumental assistance.

In the *first stage* it often depends on an undilated os uteri; this more frequently occurs with first labours, and also in women of advanced age, than under other circumstances. On examination, the os uteri is found in one of two conditions, either thin and hard, or semi-pulpy and œdematous, and but little influenced by the pains, which may be frequent and very severe. It may also be undilatable from the presence of cicatrices.

One of the most effectual remedies for this condition is venesection, which may be carried sometimes to a great extent, provided there be no contraindication. Dr. Dewees once took away as much as two

quarts. The blood should be drawn rapidly and from a large orifice; if the patient becomes faint, so much the better. The bloodletting may be assisted by an opiate enema, by the administration of tartar emetic in nauseating doses, or by the application of belladonna ointment to the cervix. The warm bath has been recommended by some practitioners, and disapproved of by others. Moral influences have, at times, a good effect; changing the dress, or the bed, changing the position, &c., are often of service. Some practitioners recommend mucilaginous injections to be thrown into the vagina.

There is another condition of the os uteri which is often a cause of delay, where the anterior lip is caught between the head and symphysis pubis and its retraction prevented. This may result either from an obliquity of the uterus, or more probably from an unequal dilatation of the anterior and posterior lips, the latter dilatating most rapidly.

The remedy is simple and easily applied. During the interval between the pains, when the os uteri is soft and dilatable, the practitioner should gently push back the anterior lip over the crown of the head and hold it there during the succeeding pains, — a proceeding which, if nicely accomplished, will soon be followed by the expulsive pains of the second stage.

Premature rupture of the membranes. — This may occur either through their own weakness, or from violence, either accidental, or from the officious meddling of the accoucheur. The result is, that the os uteri, instead of being dilated by the bag of membranes, which is soft and wedge-like, comes at once in contact with the child's head, which is not by any means so good a dilator. The only remedy is patience. An examination should be made early, in order to correct the presentation without loss of time, should it be abnormal.

Excessive quantity of liquor amnii is sometimes enumerated as a cause of tedious labour; and this is apt to be in excess when the patient is feeble, and the child small and ill-nourished. The treatment for this is rupture of the membranes; but it should not be practised without due caution, or it may produce tedious labour from the cause mentioned in the preceding paragraph.

In the *second stage*, the labour is often rendered tedious by the feeble and irregular action of the uterus; when this exists, the interval between the pains is long, and the pains themselves are feeble and short, and have little or no effect on the child. This state of things is not uncommon in delicate women, or in the reverse; or it may be produced by mental depression, a deranged state of the digestive organs, or it may arise from hereditary transmission.

In the treatment of these cases, it is above all things necessary to keep up the patient's spirits; all causes of irritation should be removed, and she should be allowed to change her position. In some cases it may be right to administer an opiate, so as to recruit her by sleep, and in all cases a stimulating enema will be found of service, especially if the bowels are loaded, and the delay depend on this cause. But the

most effectual remedy in these cases, is the *ergot of rye*, a remedy which seems to posses a power of certain, direct, and speedy action on the uterus, causing it to contract almost unremittingly till its contents are expelled. Besides the power of strengthening feeble pains, Dr. Ramsbotham has shown that it is capable of *originating* uterine action.

It may be given either in substance, infusion, or tincture, in the dose of from fifteen to twenty grains of the powder, till a drachm is taken; half a fluid-drachm to one fluid-drachm of the tincture; or, the same quantity of powder as above directed, mixed in hot milk or coffee.

It is, however, to be given with caution, as results fatal both to mother and child have followed its injudicious administration.

The indications for giving it are, according to Dr. Churchill, 1st. Feeble and inefficient pains without especial cause; 2d. If the os uteri be soft and dilatable; 3d. If there be no other obstacle to a natural delivery; 4th. If the head or breech present, and is sufficiently advanced; 5th. If there be no threatening head symptoms, nor excessive general irritability.

But, on the other hand, it should not be given, 1st. If the os uteri be hard and rigid; 2d. If the presentation be beyond reach; 3d. If there be a mal-presentation; 4th. If the pelvis be deformed; 5th. If there be any serious obstacle to delivery in the soft parts; and, 6th. If there be head symptoms, or much general irritation.

Toughness of the membranes, even after the os uteri is dilated, is sometimes a cause of tedious labour; but, when once ascertained, it admits of an easy remedy; if the pains are active, and the os uteri dilated, they may be ruptured without ceremony. The practitioner should cut a notch in his finger nail, and *saw* through the membranes, at the most dependent part, during a pain.

Sometimes they protrude unbroken, down to the os externum, and in some few cases, the child has been expelled with the bag of membranes and placenta *en masse;* under such circumstances, it would certainly be drowned in its own liquor amnii if assistance were not at hand to rupture them, and enable the child to breathe.

Rigidity of the soft parts is a very common cause of delay in women who have borne children late in life, or who are of a plethoric condition, with a well-developed muscular system. In such, the head makes little or no progress, although the pains be strong and frequent. If this condition of things last long, the patient will fall into a state of exhaustion or constitutional irritation; or inflammation and sloughing of the soft parts from long-continued pressure will ensue.

The indications in the treatment are, 1st, to *gain time;* 2d, to *counteract inflammation.* These will be fulfilled by a moderate bleeding, if the constitution will bear it; by a dose of opium, to moderate or suspend the uterine action; and by small doses of tartar emetic, with the hope of relaxing the system. To these means may be added,

warm hip-baths, warm mucilaginous fomentations to the parts, and the introduction of unirritating unguents into the vagina.

If the rigidity be dependent upon the presence of *cicatrices* of the os uteri, vagina, or perineum, the result of laceration or sloughing in former tedious labours, or occasioned by the ill use of instruments, the same rules for treatment may be adopted.

The uterus may acquire an *inclination* one way or another, during pregnancy, from different causes, and this oblique position of the organ may be a cause of delay in the progress of the labour. In women who have borne many children it is often owing to relaxation of the abdominal muscles, which permits the uterus to fall forwards, and thus the child's head, instead of being propelled into the brim of the pelvis, is driven back against the upper part of the sacrum. The nature of the obliquity is detected by a per vaginam examination, which reveals the position of the os uteri; if it be *lateral*, place the patient on the *opposite*, side; if *anterior*, let her lie on her back, and support and draw up the fundus uteri by means of a towel or napkin passed beneath the pendulous belly and fastened behind the back, until the head shall occupy the inferior strait.

There are various other causes that may render a labour tedious, such as an over-distended bladder, or a rectum filled with hardened fæces, a rheumatic condition of the uterus, tumours, and deformities of the pelvis, &c. In the first case, the remedy is found in the introduction of the catheter and drawing off the water; in the second, a stimulating injection should be given, or, if necessary, the hardened fæces removed with the handle of a spoon; in rheumatism of the uterus, the patient generally complains of feverishness and restlessness, the abdomen is tender, the urine scanty and high-coloured, for some time before labour sets in. The contractions of the uterus are rendered exceedingly painful, and at times inefficient. The treatment consists in bloodletting, warm fomentations, an aperient of mag. sulph. and sodæ carb., and alkaline drinks.

Tumours and deformities of the pelvis require instrumental aid, and render an otherwise natural labour, preternatural.

PRESENTATIONS OF THE BREGMA, OR TOP OF THE HEAD, AND OF THE BROW.

Presentations of this portion of the head are dependent upon a departure of the chin from the breast, and are regarded as deviations from an occipital presentation. There are the same number of positions of this presentation as in those of the occipital, viz.:

1. Vertex to left acetabulum.	Forehead to right sacro-iliac junction.
2. " right acetabulum.	" left " "
3. " symphysis pubis.	" promontory of sacrum.
4. " right sacro-iliac junction.	" left acetabulum.
5. " left " "	" right "
6. " promontory of sacrum.	" symphysis pubis.

The diagnosis of this presentation is readily made by discovering the quadrangular fontanelle, occupying the centre of the opening. The various positions engage less readily in consequence of the head offering a larger surface to the os uteri, and because the occipito-frontal diameter cannot readily descend into the excavation while the thickness of the walls of the neck of the uterus is added to it.

If discovered before the head has engaged, it may be corrected by pushing up the forehead and pulling down the occiput. Should the head have descended, however, the movements of flexion and rotation should be aided by the hands of the practitioner.

In all cases where the anterior fontanelle offers itself originally, there is a natural inclination for the case to be converted into a perfect face presentation; and this is owing to the fibres of the fundus uteri exerting themselves strongly upon the fœtal body; under which action the shoulders are pressed downwards, the chin is gradually separated more and more from the chest, and the head is expelled in the manner hereafter to be described.

We should endeavour to place the head in a more favourable position, by throwing the chin more upon the chest, and causing the vertex to descend; provided this could be accomplished without incurring danger, without any aggravation of suffering, and without the formidable appearance of preparing for an operation. This object can frequently be gained, if the position be detected soon after the rupture of the membranes, and before the head has perfectly engaged in the pelvic cavity, by a very simple and easy method; it only requires that steady pressure should be made upon the brow with the extremity of the finger during the urgency of pain, so that the forehead may be arrested at the spot to which it has attained, and the powers of the uterus be expended upon the back part of the head. It is then usually observed that the head is bent forward on the neck, as on a hinge; the vertex comes down, the brow remains stationary; and thus the case may be made one of the most simple, natural, and easy.

The attempt should only be made during the paroxysm of pain: it is not possible to *push* the anterior fontanelle *up above* the brim; the only intention should be to prevent it passing *down further*, and to give an opportunity for the back part of the head to occupy the pelvis more completely. This counter-pressure, nevertheless, must be made with caution, tenderness, and judgment.[1]

FACE PRESENTATIONS.

Face presentations are deviations from those of the occiput, and are not by any means as dangerous as they were formerly supposed to be. Madame Lachapelle has laid it down as a fixed principle, that this sort of labour is nearly as easy and as natural as that by the vertex, and affirmed, that out of seventy-two cases of this kind, forty-two were

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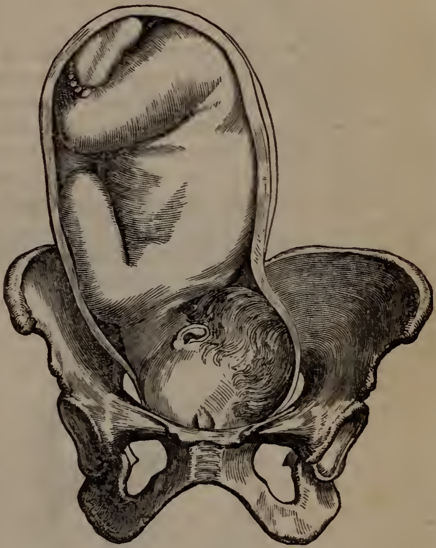
[1] Ramsbotham's process of Parturition.

delivered by the unassisted efforts of the female, without danger either to mother or child. They are therefore included under the head of *Natural Labour.*

The *causes* of face presentations are obscure, and have been variously described by authors. Some suppose that they are caused by the inclination or obliquity of the fœtus itself, rather than of the organ which contains it. Madame Lachapelle attributes them to the circumstance that the anterior obliquity of the womb being very common, the weight of the occiput must in such cases prevent the chin from being applied to the breast; and must bring the mento-bregmatic diameter into parallelism with the sacro-pubic diameter, from the very commencement of the labour. Paul Dubois thinks they are primitive, and probably produced by the active movements of the fœtus itself, and the following is his explanation. "At any time during gestation, the chin may depart from the breast; if the fœtus retains this position till the end of pregnancy, it becomes permanently fixed in it at the commencement of labour, by the rupture of the membranes, and the contractions of the uterus."

Fig. 303.



By most authors, obliquity of the uterus has been looked upon as the principal cause of face presentations. If at the commencement of labour the uterus is so oblique as to throw the fundus far over to the right side, the child presenting by the head and the vertex in the first position, the direction of the expulsive force operating on the infant will propel its head against the edge or brim of the pelvis, and either cause it to glance upwards into the iliac fossa and let the shoulder come down, or it will be turned over, so as to let the face fall into the opening, and thus produce a face presentation, in which the chin will be directed to the right side, and the forehead to the left of the pelvis. (Fig. 303.)

It will therefore be seen, from this explanation, that face presentations are deviations from those of the vertex. From this circumstance

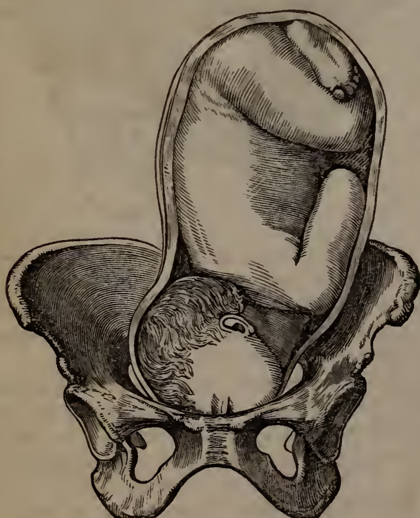
some authors make the same number of positions for them as for vertex presentations, as follows :—

1. Forehead to left acetabulum.	Chin to right sacro-iliac junction.
2. " right "	" left " "
3. " symphysis pubis.	" promontory of sacrum.
4. " right sacro-iliac junction,	" left acetabulum.
5. " left " "	" right "
6. " promontory of sacrum.	" symphysis pubis.

Others again make four, corresponding to the four *oblique* positions of the vertex, while some enumerate the same number, disposing them *transversly*, and from *front to rear*, admitting a *right mento-iliac* and a *left mento-iliac*, a *mento-pubic* and a *mento-sacral position.* These positions having all been established, it is proper that they should be mentioned. Presentations of the face, however, are nearly always resolved into two only, viz., right mento-iliac and left mento-iliac, as follows :

First position.—Forehead to the left ilium, or left acetabulum, and the chin to the right ilium, or right sacro-iliac junction, the bridge of the nose representing the line described by the sagittal suture in the first vertex position. (Fig. 303.)

Fig. 304.

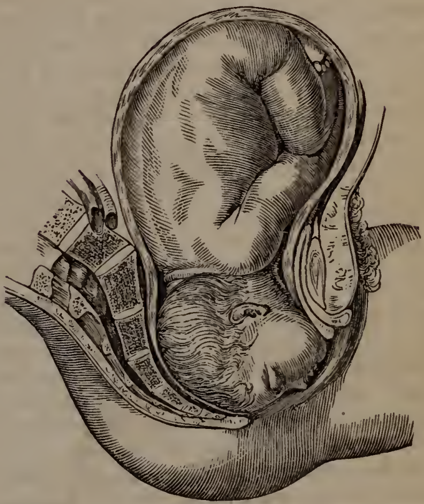


The *second position.*—Forehead to the right acetabulum, or right ilium, and the chin to the left ilium, or left sacro - iliac junction. (Fig. 304.) The first position is a deviation from either the first or fifth position of the vertex; the second, from the second or fourth.

Mechanism.—In the first position, the right side of the face is anterior, and therefore more depressed than the other on entering the brim, and the finger touches the right eye or zygoma first, on making an examination; if the labour is a long one, this part of the face is swollen and livid. The face comes down transversely with the bi-malar, or rather the bi temporal diameter, in coincidence with the antero-posterior of the superior strait, and the fronto-mental with the transverse. As the

head is forced down into the excavation, *extension* first becomes as great as possible, then the chin rotates upon the right anterior inclined plane until it gets under the arch of the pubes; while the anterior fontanelle glides in an opposite direction upon the left posterior inclined plane, and falls into the hollow of the sacrum. As the chin emerges, it rises up towards the mons veneris, performing in this case the movement of *flexion*, instead of *extension*, as in vertex cases; the forehead, followed by the sagittal suture and occiput, passes gradually down the plane presented to it by the anterior surface of the coccyx and perineum, in front of which all these parts are successively disengaged. (Fig. 305.)

Fig. 305.



The *second position* is merely the reverse of the *first;* the left side is now turned forwards, and the left eye and zygoma are lowest in the pelvis, and the ecchymosis is found on this side, if the labour is protracted. The chin rotates upon the left anterior inclined plane, and the anterior fontanelle on the right posterior one: the same diameters correspond, and the labour is completed as in the first position. It is said that this position is more frequent than the former, and that rotation is more readily effected, as the rectum offers no impediment.

In all the various positions that have been described or alluded to, the object is to bring the chin to the pubis, and the mechanism is the same as in the two varieties above described. Should this fail, and the chin rotate into the hollow of the sacrum, it is impossible for this part to be born first (unless the fœtus be an abortion); for the thorax would then be in the pelvis at the same time as the head, and would require assistance to deliver it. These cases will be treated under *Preternatural Labour.*

Diagnosis. — Generally speaking, it is not difficult, although the face has been confounded with the breech. It is generally distinguished by the prominence and regularity of the features, by the nose, eyes, chin, and mouth; the latter is distinguished from the anus by the absence of the prominence of the coccyx, and by the sphincter

ani; the best means of diagnosticating face presentations is by the bridge of the nose, which from its *crossing* the os uteri may be detected at a very early period of labour; it is better than the eye, which may not only be injured, but may mislead; it is better than the malar bones, for these may be mistaken for the tuber ischii, or even for the shoulder. The nose not only tells the presentation, but also the *position*. After the face has descended, the chin will confirm it.

Treatment. — Face presentations require more laborious effort for delivery than others, from the fact that the cephalic extremity is removed from the line of direction in which the uterus and accessory powers act. The second stage is also longer, because the bones of the face are incompressible, and there is not the same adaptation to the parts through which it is to pass.

In ordinary cases little is required beyond watching the case carefully, cheering and supporting the patient. If called early enough, endeavour to rectify the presentation; if not, to bring the chin to the pubis by the gentlest assistance. In most cases no interference is required; the general rules already given are sufficient. The features of a child born under a face presentation are generally much swollen, turgid, and livid. We must be prepared, therefore, to expect some disfigurement, which, however, will generally disappear in a day or two.

Other deviations from the vertex presentations sometimes occur from the operation of the same or similar causes. The head may descend half turned over, so that the occipito-frontal or occipito-mental diameter corresponds to those of the straits, as shown before (p. 541). In this case either the anterior fontanelle or forehead will be the presenting part. Sometimes the head is too much flexed, occasioning a part of the nucha to present with the occiput. Again, it frequently happens that one of the parietal bones, or the ear, or the temple, being nearly parallel with the plane of the superior strait, engages first. Such cases may either correct themselves, or become the cause of preternatural labour.

PELVIC PRESENTATIONS.

Under the head of pelvic presentations are included those of the knees and feet; it matters but little, so far as the mother is concerned, which end of the fœtal oval presents at the superior strait, since either can be born unassisted. These pelvic presentations are, however, more dangerous to the child than cephalic, either from the fact that the placenta is often detached from the uterine surface before the head is born, or from pressure upon the umbilical cord during the exit of the head, either case being attended by the same result, viz.: *asphyxiation of the child.* All practitioners agree that the child is oftener born dead in pelvic presentations than in those in which the vertex descends first.

Causes. — Breech labours occur once in about every forty-five or fifty cases; why they occur this often, or why they happen at all,

appears to be inexplicable. Madame Lachapelle explains their occurrence as follows: — During a great part of gestation, and whilst the fœtus still movable in the cavity of the uterus, its long diameter can be readily brought into coincidence with the transverse diameter of that organ; its position therefore is by no means fixed, and it can, by virtue of its active movements, present any part of its surface at the uterine orifice, but especially the cephalic or pelvic extremities. The latter part may occupy the superior strait at any period of gestation, in consequence of the movements of the fœtus, and may remain in that situation for an indefinite period. It happens, then, if the fœtus in this time should have developed itself to any extent, it cannot turn, and it will be apt to retain the attitude it may then acquire till the end of pregnancy, as its length does not readily admit of its passing the transverse diameter of the uterus.[1] Violent movements on the part of the female, it is thought, may also be a cause of pelvic presentations, but, as before stated, they are, in the great majority of cases, inexplicable. Some women, from original conformation or other causes, appear particularly obnoxious to this mischance, bringing all their children into the world by breech labours.

Prognosis.—Breech labours are generally more tedious than cephalic, inasmuch as the pelvic extremity is not so good a *dilator* as the cephalic; it never presents the same evenness, the same resistance, or the same rounded form as the head to the openings of the pelvis; it consequently acts to much less advantage on the cervix to finish its dilatation. In vertex presentations the most voluminous part, that which is best calculated to bear all kinds of pressure, escapes first. In pelvic presentations, on the contrary, the point of the cone advances first, so that the fœtus progresses more slowly in proportion as the labour advances.

Positions. — The same difficulty occurs in enumerating the various positions of the breech that we have seen obtain in the other presentations, every author recording those which seemed to him best established. Thus some make as many as eight; among these is M. Flamant, who makes one for each extremity of the different diameters of the superior strait, viz.: two for the antero-posterior, two for the transverse, and two for each of the oblique, making eight in all. Others make six, corresponding to the different positions of the vertex, the sacrum taking the place of the vertex, as follows:—

1.	Sacrum to	left acetabulum.	Post. part of thighs to	right sacro-iliac junction.
2.	"	right "	"	left " "
3.	"	pubes.	"	prom. of sacrum.
4.	"	right sacro-iliac junction.	"	left acetabulum.
5.	"	left " "	"	right "
6.	" to sacrum	" "	"	pubes "

We find, again, some reducing them to four, viz.: 1st. Sacrum to the left acetabulum; 2d. To the right acetabulum; 3d. To the pubes;

[1] Chailly, Traité Pratique de l'Art des Accouchemens, p. 604.

4th. Sacrum of the child to the promontory of sacrum of the mother.

Fig. 306.

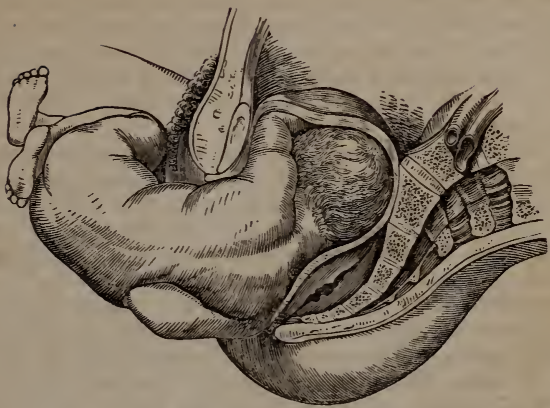
Thus the direct positions, either anterior or posterior, are possible, as well as the diagonal ones, and the breech, *may* present in as many ways as the head.

To simplify the matter, however, most of the recent writers reduce them to two, viz.: *sacro-anterior*, and *sacro-posterior*, that is, the back of the child towards the belly of the mother, and the back of the child towards the back of the mother. Not that the back of the child is *directly* anterior or posterior, but oblique, the transverse diameter of the child's hips corresponding to one or other of the oblique diameters of the superior strait. (Fig. 306.)

Mechanism. — The mechanism of the sacro-anterior positions is so much alike, that but one description will be given of them. Naegelé, on the mechanism of parturition, says, that "In every case, whether the nates have at first a completely transverse or oblique direction, they will be always found, on pressing lower into the superior aperture of the pelvis, to have taken an oblique position; and that ischium which is directed anteriorly, to stand lowest. In the most common position, where the sacrum of the child is towards the left acetabulum, as the breech descends into the pelvis, it is the left ischium that stands lowest, and is first touched by the finger. The child's left hip rotates forwards upon the right anterior inclined plane under the arch of the pubis, while the right hip slides backwards into the hollow of the sacrum along the left posterior inclined plane. As the shoulders are supposed to remain fixed in the uterus, flexion of the child's body takes place as it is being born, and restitution after the birth of the hips is effected. As the shoulders also engage obliquely, they undergo rotation, the left shoulder rotating on the right anterior inclined plane, and appearing under the pubis, while the right falls into the hollow of the sacrum (Fig. 307).

"But whilst the shoulders are descending in the above-mentioned oblique position, the head, with the chin resting upon the breast, presses into the superior strait in the direction of the right oblique

Fig. 307.



diameter, that is, with the forehead at the right sacro-iliac junction, the occiput rotates upon the left anterior inclined plane, towards the pubis, and the forehead on the right posterior, into the hollow of the sacrum, and the head is born in such a manner, that whilst the occiput rests against the os pubis, the point of the chin, followed by the rest of the face, sweeps over the perineum, as the head turns on its lateral axis from below upwards (Fig. 308).

Fig. 308.

"There is no essential difference in the mechanism of the labour, when the sacrum is at the right acetabulum, except that the rotation

is reversed; the right hip and shoulder rotate on the left anterior inclined plane, and the left hip and shoulder on the right posterior inclined plane; the occiput on the right anterior, and the forehead on the left posterior inclined plane. As before mentioned, when the sacrum is to the pubes, as it descends it becomes oblique, and then the mechanism is precisely the same as above described. (Figs. 307, 308 describe these.)

"As in positions of the cranium, the swelling of the integuments is chiefly met with on that parietal bone which, during the passage of the head, is situated lowest, and on that spot with which it enters the external passage, so in this case, the livid-coloured swelling appears on that part which, directed forwards, was situated lowest during the passage of the nates, and with which the nates were born."

In the second chief position, viz., with the anterior surface of the child corresponding to the anterior abdominal parietes of the mother, or in other words, with the sacrum of the child to the sacrum of the mother, the same effect is produced by the expulsive action as before. The breech descends to the outlet of the pelvis; a slight turn is effected; one of the ilia (and it is generally the left) appears under the arch of the pelvis, the other traverses the perineum; the breech and legs escape, the shoulders pass the brim, and descend until they press upon the structures at the outlet; one escapes under the arch of the pubes, the other follows the curve of the sacrum, and the head is propelled into the cavity of the pelvis, with the face looking to one side, and the occiput to the other.

It might be supposed, from the position of the head at the commencement of labour, with the face looking forwards, that the *occiput* would fall into the hollow of the sacrum, and the *face* emerge under the pubes; but this is not the case; for when the shoulders are born, and the head is in the pelvis, the face is directed to one side or the other, exactly as in the sacro-anterior position; and a precisely similar turn is effected, the face falling into the hollow of the sacrum; so that the fœtus in its exit makes a semicircular rotation, the face being placed forwards at the commencement of labour, and being expelled through the outlet over the sacrum and perineum. Dr. Ramsbotham, from whom the above description is taken, says farther, "I believe that in no instance, if the case were left entirely to nature—provided the child and pelvis were of the common size and form — would the face be expelled under the arch of the pubis." Dr. Collins also confirms it. Dr. Naegelé mentions this last as a deviation from the ordinary mechanism of breech cases. He also describes another deviation, in which the chin departs from the breast, and the head enters the pelvis, after the birth of the body, with the occiput pressed against the nape of the neck, and the vertex corresponding to one or other ilium of the mother. As the head presses lower into the cavity, the vertex turns gradually more and more backwards, so that when the trunk is born, the arch of the cranium is directed to the hollow of the

sacrum, and the inferior surface of the lower jaw to the symphysis pubis. In the birth of the head, whilst the under jaw presses with its inferior surface against the os pubis, the point of the occiput, with the vertex, followed by the forehead, sweeps *first* over the perineum; thus bringing the occipito-mental diameter into apposition with the antero-posterior of the outlet.

The *diagnosis* of breech presentations has already been given; it is not usually difficult. It may be confounded with the face, particularly where the labour has continued for some time, and the presenting part is tumid. It will be distinguished from the latter by the absence of the bridge of the nose, by the movable, *single* point of the coccyx, by the contractility of the sphincter ani, by the tubera ischii, by the cleft between the nates, by its roundness and softness, and by the organs of generation. Of these, however, the point of the coccyx and the sacrum are the best, as the others may be so altered by swelling as not to be recognisable. The presence of the meconium is not a certain sign, since it is occasionally met with in cephalic presentation, where the child is subjected to strong pressure, though in the latter case, Dr. Collins says it is more fluid, from being mixed with the discharges from the uterus and vagina.

The *shape of the bag of waters*, is another diagnostic sign, being less hemispherical and more cylindrical than in vertex presentations, and more resembling an intestine in shape.

Auscultation, though not a certain test, is a corroborative proof; the sound of the fœtal heart will be heard higher in the abdominal region, if the head be at the fundus uteri, than if it be seated in its more natural position. The same is true of the *movements* of the fœtus, they being generally felt *lower* in the abdomen in breech cases, than in those in which the vertex presents.

Presentations of the breech, although perfectly natural labours, are generally more tedious for the mother, and more dangerous for the child than those of the head, for reasons already stated, viz.; that when, in pelvic labours, the head enters the pelvis, if everything be not favourable for its passing rapidly through it, the cord is so long compressed that the child is almost certainly lost.

Treatment. — Much more care and attention are required in the treatment of these labours, than in those before described; not only to protect the soft parts of the mother, but also to preserve the child's life, which is always placed in more or less danger. It is, therefore, of great importance that a correct diagnosis should be made early. Being satisfied that it is the breech which presents, the case requires no interference until the breech shall have been expelled through the external parts, further than to guard the soft parts of the mother, and carefully to support the perineum. Above all things, the attendant should not draw down the feet, as the inexperienced are too apt to do, in the hope of facilitating the delivery by having something to pull upon; this practice always diminishing the size of the dilating part,

and thus *prolonging* the labour. As the breech escapes, it should be supported and carried upwards in the axis of the pelvis, allowing it perfect liberty to change its position or make such turns as the mechanism may require. Mechanical assistance is rarely required in these cases, the child *adapting itself* to the passages of the mother.

When the umbilicus appears at the external organs, the cord should be seized and gently drawn down and pushed to one side; this wil prevent its being torn and pressed upon.

The *strength* of the *pulsations* in *the cord*, is the *best evidence we have* of the *necessity* for *any interference.*

When the thorax has emerged, if the arms have not escaped with it, they should be brought down by passing one or two fingers over the shoulders, as near as possible to the elbow, and then drawing the arm *across the face* and *chest* until the elbow arrives at the external orifice; having delivered one, the other is easily extracted. It is generally better to deliver the one at the perineum first.

The slower the pelvis and body pass out, the quicker will the head pass, and the greater will be the chance of saving the child's life.

The body being born, it should be wrapped in warm flannel, and raised upwards on the practitioner's arm, to a height sufficient to enable the longest diameter of the head to become parallel with the axis of the vagina, and the patient urged to bear down.

If the head be delayed while in the vagina there is danger of losing the child; the extent of this danger will be estimated by the pulsa-

Fig. 309.

tion in the cord. As in most cases the head will be found with the face in the hollow of the sacrum, the delivery may be hastened by introducing one or two fingers of the left hand into the mouth, and depressing the chin upon the breast, at the same time carrying forward the body of the child. (Fig. 309.)

If this fail, the perineum should be pressed back so as to allow the atmospheric air to enter to the respiratory organs, or a *quill* should be introduced into the mouth of the child, as recommended by Prof. D. Gilbert, through which respiration may be carried on. The child, in this way, may be saved till the expulsive efforts effect the delivery. Should these means fail, and the child be in danger, the forceps should be at hand, and the child be delivered by their assistance.

If it should happen that the body is expelled with the face anteriorly, and the chin should lodge upon the pubes, it should be carried *backwards*, and the chin drawn down by the finger introduced into the mouth. The remainder of the delivery and the after treatment, are the same as in vertex presentations.

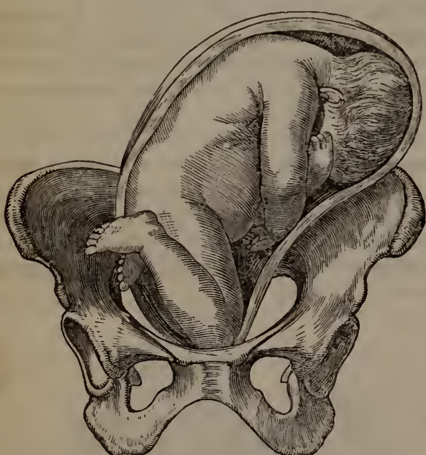
Presentations of the inferior extremities.—What has been said in relation to the danger of breech presentations, applies with even much force to those of the lower extremities. In this latter case the child may be compared to a *cone*, the apex of which presents itself first. Of course, under these circumstances, the pressure upon the child is constantly increasing as it descends, and the external parts not having been thoroughly dilated, when the body is born and the head engages, it is much more liable to prove fatal to the child in consequence of the detention that almost unavoidably ensues; the *prognosis*, therefore, in such cases is less favourable than in a *simple breech presentation.*—*Diagnosis.* Presentations of the feet may be readily distinguished. Before the membranes have ruptured, the bag of waters often protrudes in a more cylindrical form, or like the finger of a glove, and we discover that the presenting part is smaller than either the head or breech. At this stage we cannot readily distinguish whether it be

Fig. 310.

the superior or inferior extremity that presents. After the membranes have ruptured, the *foot* will be recognised by its greater length, by the rounded instep, by the uniform length of the toes, by the absence of a thumb, and by the presence of the heel with the ankle bone on either side. The *knee* may be distinguished from the elbow, with which it is liable to be confounded, from the fact, that it is thicker, that it has two prominences, and a depression between them; while the elbow, which is thinner, presents, between the two prominences, a projection, in which it seems to end. (Fig. 311.)

Positions of the feet.—Most accoucheurs enumerate *four* positions for footling presentations, viz.; 1st. Heels behind the left acetabulum, loins in front and to the left. 2d. Heels behind right acetabulum, loins forward and to the right. 3d. Heels behind the pubis, loins directly in front. 4th. Heels to the promontory of the sacrum. There are others who enumerate six, corresponding with vertex positions, and others again as many as eight, corresponding with those of the sacrum mentioned in the beginning of this article. (Fig. 310.)

Fig. 311.



Following the arrangement adopted in relation to breech presentations, we enumerate but *two*, viz.: a *calcaneo-anterior*, and a *calcaneo-posterior*. 1st. When the heel is directed forwards and the toes backwards. 2d. When the heel is backwards and the toes forwards. The former is the more frequent, and both correspond to the two classes of breech presentations. (Fig. 311.)

The *positions of the knees*, have also the same varieties, the *anterior* parts of the leg corresponding to the sacrum and the vertex; and as they are commonly converted into footling cases, they do not require a separate description. (Fig. 311.)

Mechanism.—The feet meeting with no resistance to fix them, are liable to change their position during their descent until the hips enter the brim, which they do precisely as in breech cases; the mechanism, therefore, is the same, and does not require a further description.

Treatment.—The same rules apply to the treatment of presentations of the inferior extremities that were laid down in breech cases, with

the additional caution, *not* to *yield* to the *temptation* to *pull down* the *feet;* the dilating part is already too small for safety, and if it be diminished by this procedure, the child will almost certainly be lost by pressure upon the cord during the descent of the head

PRETERNATURAL LABOUR.

Preternatural labour or *dystocia*, signifies a faulty, or irregular labour, the course of which is unfavourable, and in which the assistance of the obstetrician becomes necessary. It will be remembered that this definition applies to all cases of labour, without reference either to presentation or position, in which manual assistance becomes necessary.

According to Velpeau, the causes that render labour difficult, depend either upon the mother or the child. Some of them are unforeseen, or do not occur till the moment of parturition; the title of *accidental* may be appropriated to them. Others exist beforehand, and render the labour necessarily difficult; they merit the denomination of *pre-existing* causes.

The *accidental* causes are: any serious disease, such as inflammation of the brain or its coverings, the lungs, pleura, peritoneum, or uterus, &c., which takes place during labour; any hemorrhage sufficiently abundant to endanger the life of the mother, or her offspring; convulsions, syncope, laceration of the womb, the premature escape of the cord, hernia, aneurism, asthma, great debility, &c., and some positions which do not become bad until after the first pains.

The *pre-existing* causes are: deformities of the pelvis, malformation or disease of the organs of generation, calculus in the bladder, fibrous or other tumours in the excavation, deformities in respect to height, transverse positions, monstrous conformation and diseases of the fœtus.

As these different causes are in reality only complications of labour, it follows that *Dystocia* comprises all cases of complicated labour, as *Eutocia* comprehends all simple labours.

From the occurrence of any of the above-mentioned causes, one of the following operations may become necessary, to wit: *turning*, the *application of the forceps*, or *craniotomy*. The first of these most frequently becomes necessary in cases of transverse positions of the child, as in presentations of the shoulders. As the mode of proceeding is the same whenever the operation becomes necessary, it will be described only in cases of *shoulder presentations*.

PRESENTATIONS OF THE SUPERIOR EXTREMITIES.

In almost all cases of this kind it is the shoulder which presents itself at the superior strait, but it may happen that instead of a shoulder, a hand or elbow may be prolapsed; still, when they are advanced to a certain degree, it is the shoulder which fills the strait and presents the obstruction. The descent of the arm or hand add nothing to the

difficulty; indeed it is rather serviceable, since it assists us in our diagnosis, and does not at all interfere with the successful termination of the labour. In this respect it differs from breech presentations, in which the descent of the feet is altogether to be avoided.

In all cases of shoulder presentation the back of the child either looks forwards towards the abdomen of the mother, or backwards towards the spine; the former is twice as frequent as the latter.

It need hardly be said, that in the majority of such cases, the delivery is impracticable except by art, although there are cases reported of what is called *spontaneous evolution*, in which the child has *righted* itself, the arm and shoulders receding, and the breech descending in its place, the labour being completed by the unassisted efforts of the mother.

Although spontaneous evolution *may* take place, it is more conformable to the dictates of prudence and humanity to turn the child, and bring down the feet, or restore the head to its proper place.

Causes.—There have generally been enumerated but two great presentations, viz., the *cephalic* and *pelvic*,—all others are but deviations from these. As footling and knee presentations are deviations from the breech, so are those of the shoulder from cephalic. Various causes have been enumerated; among them are particular positions of the mother's body, inclination of the womb or of the straits of the pelvis, sudden and irregular movements of the fœtus, irregular early contractions of the womb, and irregular distension. Dr. Rigby concludes that the causes of arm or shoulder presentations are of two kinds, viz., when the uterus has been distended by an unusual quantity of liquor amnii, or when, from a faulty condition of the early pains of labour, its form has been altered, and with it the position of the child.

Dr. Meigs looks upon obliquity of the womb as the great cause. When the fundus falls over to either side, the action of the uterus is oblique, the head, instead of engaging in the superior strait, strikes against the brim of the pelvis, and glancing off from thence, is turned upwards into the costa of the ilium, while the shoulder descends or engages in the superior strait.

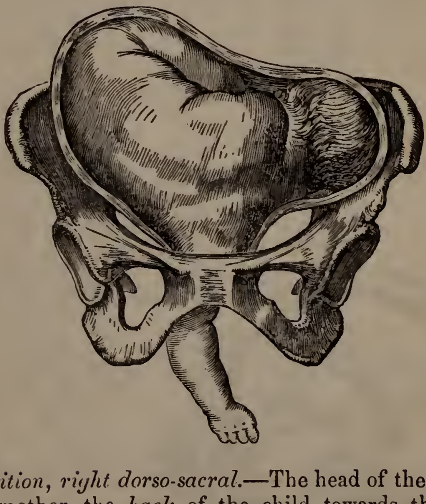
Diagnosis.—It is only when the labour has commenced, and indeed made some progress, that a shoulder presentation can be positively detected. It may be *suspected*, if we are unable to reach the presenting part, if the os uteri, though flaccid, opens slowly, if the bag of waters is cylindrical, or like the finger of a glove, and if the uterus ceases to act after the membranes have been ruptured for some time. We can only *positively* detect the presentation by distinguishing the different parts of the child, as, for instance, the spinous process of the scapula, the clavicle, the round-shaped shoulder, the axilla, the ribs, the arm, and in some cases the hand when prolapsed, distinguished from the foot by the means already pointed out. The aspect of the palm of the hand will mark whether it be the right or left. The diag-

nosis between the *breech* and the *shoulder* will be easy, if the distinguishing marks of the former are remembered.

Positions. — There are two positions for the presentation of each shoulder, viz., a *first* and *second* for the *right shoulder;* and a *first* and *second* for the *left.* In *both* the first positions the head is on the left of the mother, and in both the second, on the right. As shoulder presentations are deviations from *vertex* presentations, the *first* positions are the most common. These positions are called the *dorso-pubic* and *dorso-sacral* of the right, and *dorso-sacral* and *dorso-pubic* of the left shoulder.

Right Shoulder.—First position, right dorso-pubic. — The head of the child is to the *left* of the mother, the *back* of the child is towards the *front* of the mother (dorso-pubic), and the *face* of the child with its toes and feet look towards her back. (Fig. 312.)

Fig. 312.



Second position, right dorso-sacral.—The head of the child is to the *right* of the mother, the *back* of the child towards the *back* of the mother (dorso-sacral), and the *face* and *front* of the child look towards the front of the mother. (Fig. 313.)

Left shoulder, left dorso-sacral. First position.—The head is on the *left*, the *face* and *front* of the child look forwards, and the *back* is to the back of the mother (dorso-sacral of the left.)

Second position, left dorso-pubic. — The head is to the *right*, the *face* and *front* of the child look backwards, and the *back* is towards the front of the mother (dorso-pubic of the left).

Treatment.—Having ascertained that the case is a *shoulder presentation,* the indications are to deliver by the operation of *turning,* or

Fig. 313.

version; by which is understood "the act of turning the child with the hand, and bringing one of the extremities of its great diameter to the superior strait." (Velpeau.)

There are three varieties of this operation described by obstetrical writers:—*First, Version by the head,* in which the presenting part is pushed away, and the head substituted for it; the remainder of the labour being left to nature. *Second, Version by the breech.*—Where the pelvic extremity of the child is substituted for the presenting part, and the case converted into a *breech labour. Third, Version by the feet,* in which the hand is introduced into the cavity of the uterus, one or both feet seized and brought down, causing the child to make a complete evolution, and extracting it footling. (Fig. 314.)

Fig. 314.

The first and second methods, although safest for the child, are rarely employed, in consequence of the difficulty of seizing and moving the parts mentioned into a more favourable condition. The third is the mode of practice generally adopted, and although more dangerous to the child, it is

safest for the mother, since it gives the attendant more complete control of the case. It is the mode of delivery now almost universally adopted, both in this country and Europe.

Method of Procedure.—The operation ought never to be attempted till the os uteri is *dilated*, or *dilatable;* the fittest moment is when the os uteri is *fully dilated* and the *membranes unruptured*. If the os uteri is rigid and unyielding, the proper means of relaxing it should be first adopted; the rectum and bladder should also be thoroughly evacuated, and the *position* carefully ascertained.

The patient should be placed in the position most convenient to the operator; some recommend that on the back, with the hips on the edge of the bed, and the knees supported by assistants; some on the hands and knees; others prefer the ordinary position on the left side. The *choice of the hand* depends on the position: the rule is, *use that hand whose palm, when opened in the cavity of the womb, looks towards the abdomen of the child.* Some recommend the use of the right or left hand, according as either is most convenient. It should be well oiled on the outside, and introduced in a conical form, into the vagina, during a pain; it will then be ready to enter the os uteri as soon as the pain goes off. The presenting arm is never an impediment, and should not be removed.

When the membranes remain unruptured, the hand should be gently insinuated between them and the uterus, until the feet (or *one* foot) are found, always stopping and opening the hand on the accession of a pain.

Be certain that it is a foot that is seized. *Now* rupture the membranes and draw the feet, or foot, with a waving motion, slowly into the pelvis. By this method the liquor amnii is retained, the uterus kept distended, and the child turned with as great facility as in a "bucket of water."

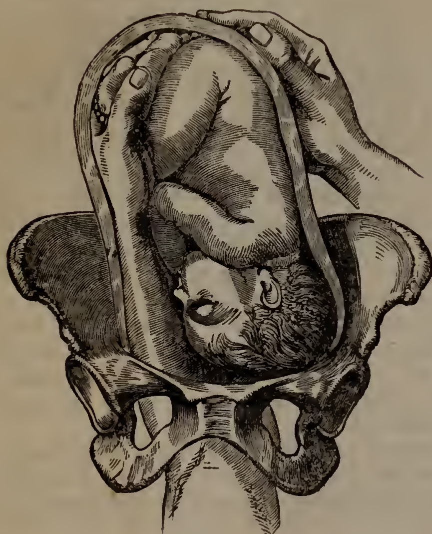
The act of turning should be accomplished during an *interval* of pain, thus the danger of rupturing the womb will be avoided. External pressure with the unoccupied hand favours the version very considerably, and should never be neglected. In turning, the feet should be brought over the *front* of the child, and not over the back, thus avoiding dislocation of the spine.

The *extraction* should be accomplished *during* a pain, always remembering the axis of the pelvis, and being careful not to place the fœtus in a wrong position, but endeavouring to make the face fall into the hollow of the sacrum. The case is now a footling one. When the membranes are ruptured, and the waters drained off, additional care is necessary not to *force* the uterus, but to endeavour to promote relaxation by the proper means, and above all to use gentleness in overcoming the contractions.

It is considered advisable by some practitioners to turn by *one* foot only, inasmuch as the breech with the thigh turned up, is more bulky than the hips with the thigh extended; the passage will be better pre-

pared to admit the quick transit of the child's head, upon which the safety of the infant depends. After the case has been converted into a footling, it should be treated as though it were so originally, that is, left as far possible to the natural expulsive powers.

Fig. 315.



Version in cephalic presentations, is accomplished by the same method of proceeding: the same rules applying for the choice of the hand, &c., as in shoulder presentations. This operation sometimes becomes necessary in hemorrhages before delivery, either accidental or unavoidable; convulsions; prolapsus of the cord; syncope; &c., thus converting what would otherwise have been a natural, into a preternatural labour. (Fig. 315.)

When the operation of turning is entirely impossible, it may become necessary to deliver the mother either by *exvisceration,* or *decapitation.*

THE FORCEPS.

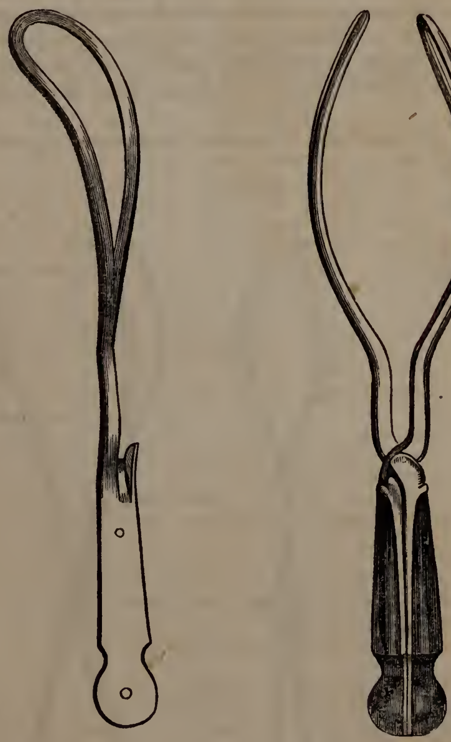
It would be manifestly out of place, in a work of this kind, to enter into a detailed history of the forceps. Suffice it to say, that although hinted at by the ancients, we find no record of their discovery or application, till the beginning of the seventeenth century, when Dr. Hugh Chamberlayne published a translation of Mauriceau, in the preface of which he declares that his father, brother, and himself, "have, by God's blessing and our industry, attained to, and long practised, a way to deliver women without any prejudice to them or their infants." "By this manual operation, a labour may be despatched (in the least difficulty), with fewer pains, and sooner, to the great advantage, and without danger, both of woman and child."

The merit of the discovery, therefore, seems to rest with Dr. Paul Chamberlayne, by whom and his sons it was kept a profound secret, till about the year 1715, when it was made public. Since that time, the instrument has undergone various modifications, always, however,

retaining the general form originally given to it. The English generally prefer the short forceps, the French and German the long. In this country the long forceps are most generally used.

The forceps are intended for the extraction of the child's head, *and nothing else.* They possess the twofold power of, 1st, grasping and slightly compressing the child's head; 2d, that of acting as a lever of the first kind, and as an extractor. They are to be applied to no other part of the child's body than the head, and are not designed to be used in cases of premature delivery, or where the head is larger than natural from abnormal growth.

Fig. 316.



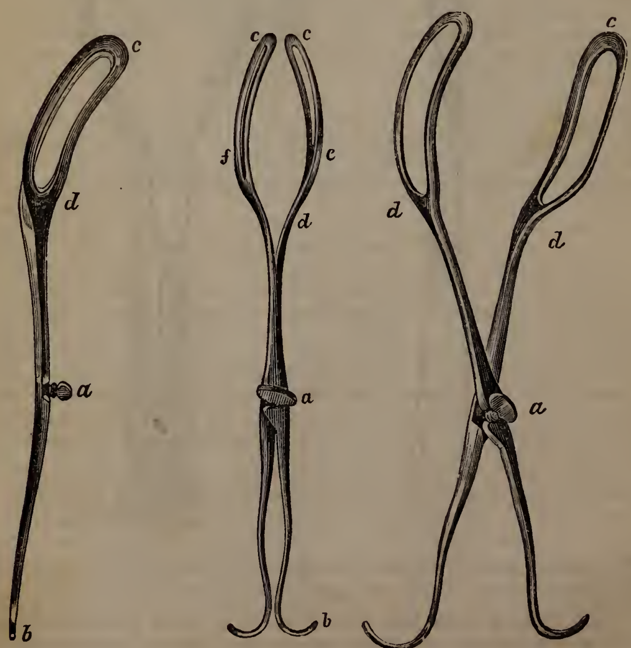
This instrument consists of two branches or pieces, one intended to be used by the right hand, the other by the left. The first is called the *right hand* blade; the second, the *left hand* blade, or branch. Each branch consists of three parts, viz.: the blade, or clam, the

lock, and the handle; in some instruments the handle terminates in a blunt hook. The clam or blade, ought, if possible, to be applied to the side of the child's head, and not to the face or vertex, and should extend from the vertex to the chin. It is provided with an open space called the *fenestra,* which not only renders the instrument lighter, but enables it to be more accurately applied to the sides of the head. The *lock* consists either in a *pivot* in one branch, which is called the male blade, and a notch in the other, called thence the female blade, which is the German lock; or a notch in the upper surface of the left, and in the lower surface of the right branch, which is the English lock.

The original forceps (and at this day, many of the English forceps) were *straight* in the direction of their length; that is, they had only one curve, that which applied itself to the child's head. Drs. Smellie and Levret, both about the same time, gave to the blades a new curve on the edges, so as to adapt them to the axis of the pelvis. This modification is therefore often spoken of as the "*New curve.*" (Fig. 316.)

The "*eclectic forceps,*" as modified by Professor Hodge, of the Uni-

Fig. 317.



versity of Pennsylvania, combines the advantages of both the long and short forceps. Fig. 317 represents them: *a*, lock; *b*, blunt hook at end of handle; *c*, *d*, clam; *e*, *f*, the fenestræ.[1]

[1] The following description of this modification of the forceps, is given by Dr. Hodge himself: "The great object of the forceps is to extract the head of the fœtus from the mother's organs, in suitable cases, without injury to the mother or child. It is notorious that injuries to one or both parties frequently result, exciting a too well-founded dread of this instrument in the minds of females, and even of physicians. Many causes contribute to this unfortunate result. No doubt much depends on the size, weight, and especially on the form of the instrument employed, a fact confirmed by the almost innumerable varieties which have been suggested. The instrument, as heretofore used, is evidently imperfect; and the one now suggested, is presented under the impression that, while it maintains all the excellencies of the former varieties, the injurious influences are partly, if not wholly, avoided. It is a modification of the long French forceps, but may be well termed an eclectic forceps, as combining, as much as possible, the peculiar excellencies of the English, German, and French varieties.

"The advantages of the French or long forceps are, I think, many and decided, as 1st, by them, any operation pertaining to this instrument, can be performed. There is no necessity to vary the form, structure, or size, of the instrument, whatever may be the presentation of the head, its position, or its location. 2d. By them, sufficient power can be applied in cases of necessity, which cannot be done by the short forceps. Their leverage is greater. 3d. The narrowness of the blades, which, without detracting from the utility of the instrument, will allow of their application to the sides of the head, even in oblique and transverse positions. Many of the modern English forceps, are too broad to allow the proper manipulation of the instrument in the cavity of the pelvis. They cannot be introduced through the vulva without pain, especially in first labours. The French forceps can very generally be applied without pain.

"4th. It may be added as another advantage, that as habit in the use of an instrument is all-important, the practitioner will sooner become accustomed to a forceps which he can employ on all occasions, than when he is obliged to vary it continually; especially when it is remembered that among the strong and well-formed females of America, cases for the forceps are not very numerous in the circle of any practitioner.

"The disadvantages, which experience has taught me to arise from the French forceps, are—

"1st. Its unnecessary weight.

"2d. The pelvic curve, in the variety most in use in this country, is not sufficiently great. Hence when the head is high in the pelvis, the perineum will be too much pressed upon, or else the blades will be applied in the direction of the occipito-frontal or longitudinal diameter, instead of the occipito-mental or oblique diameter.

"3d. The divergence of the blades commencing at the joint must necessarily distend the vulva (especially its posterior margin) prematurely, and when the head is high up, gives pain and endangers the laceration of the perineum.

"4th The small size and kite-like shape of the fenestra prevent any portion of the cranium, even of the parietal protuberances, projecting into their openings: hence the hold on the head is less firm, and space is occupied by the blades, the thickness of which is added to the transverse diameter of the head.

"5th. The flatness of the internal or cephalic surfaces of the blades — so

Indications for their Use. — The forceps are indicated, 1st, where nature is unable to expel the child, either from a want of sufficient

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that the margin of the fenestra. often measuring three-eighths of an inch, is much thicker than the external edge of the blade — increases the space occupied by the instrument. Hence in cases of difficulty, where compression is employed, contusion or even wounding of the scalp results.

"6th. The mode of junction of the French forceps is decidedly inconvenient when compared with the English, and especially with the German mode.

"These disadvantages I have endeavoured to obviate without diminishing or circumscribing the utility of this most valuable instrument, to which the profession and the public are so much indebted. My experience encourages the hope, that the attempt has been in a very great degree successful, so that even in inexperienced hands, the dangers of the forceps have been materially lessened.

"1. The weight of the instrument has been diminished from twenty ounces, avoirdupois, to seventeen ounces.

"2. The pelvic curve has been slightly increased, so that the perineum may not be dangerously pressed upon when the blades are in the axis of the superior strait. To counteract any loss of power which may ensue from the increased curvature, there is an angular bend in the handles, in an opposite direction, that the direct line of traction may be preserved, a suggestion of our skilful and experienced instrument-maker, Mr. Rorer.

"3. The shanks or commencement of the blades are nearly parallel, diverging no more than is absolutely necessary, until they approximate the head of the child, when a more rapid curvature, than in the Levret forceps, occurs.

"4. The proper blades of the instrument, from the shanks to the extremities, are nearly of the same breadth throughout, being equal to that of the extremity of the French forceps.

"5. The advantages are a more secure hold of the head, and especially allowing larger fenestræ, so that the parietal protuberances may project into the openings, and no space be occupied by the blades, when properly applied.

"6. The cephalic surface of the blade is concave, so as to be adapted to the convexity of the head, as suggested by Dr. Davis in his improved forceps, hence no edges touch the scalp, and there is no wounding of the tissues, even when great compression is made.

"7. The very ingenious and scientific mode of locking the blades, as in the German or Siebold's forceps, by means of a conical pivot, and the corresponding oblique conical opening for its reception, is adopted, by which all the facilities of the English junction are enjoyed, and the security and firmness of the French joint are maintained.

"The eclectic forceps weighs one pound and one ounce, being nine ounces lighter than the French forceps, as usually manufactured by Rorer, of this city, and eleven ounces lighter than a specimen of Dubois' forceps in my possession, made in Paris.

"The whole length of the instrument (see Fig. 317), in a direct line from *b* to *c*, is 16 inches; from the joint *a* to the extremity *b*, the length of the handles is 6·8; from *a* to *d*, length of parallel shanks is 3·5; from *d* to *c*, the proper blades in a direct line, is 6 inches; from *c c*, the extremities, to *e f*, the greatest breadth, 3·7 inches.

"The separation between the points *c c*, when the handles are in contact, is ·5 of an inch; from *e* to *f*, the greatest breadth when the handles touch, is 2·5; when the separation at *e f* is 3·5, the points *c c* are separated to 2 inches; the breadth of the blade is 1·8, slightly tapering to 1·7 near *c c*, the extremities. The breadth of the fenestra is 1·1; the thickness of the blade is ·2 of an inch. The perpendicular elevation of the points *c c*, when the instrument

power, or when the labour is arrested by certain malpositions of the head at the brim, or in the cavity of the pelvis; 2d, whenever the labour becomes dangerous for mother or child, and where the danger can only be removed by hastening the labour.

It is meant, when the *forceps* are used, to supply with them the insufficiency or want of labour-pains; but, so long as the pains continue, there is reason to hope they will produce their effect, and therefore justify waiting.

The first stage of labour must be completed, that is, the os uteri must be dilated, and the membranes broken, before the attempt is made to apply the forceps. They are never to be used as *dilators.* Care must be taken, however, that, from an aversion to the employment of instruments, their use is not too long delayed, and thus the benefit to be derived from their application be entirely lost.

The most favourable case for their application is, where the head is at the inferior strait; the nearer the head is to the external organs, the more readily may the instrument be adjusted to it, especially if *rotation* have taken place. It is very rarely, if ever, necessary to apply them, where the head has not yet passed the superior strait. The forceps should always, *if possible*, be applied over the ears of the child; it is a good rule, therefore, always to find this part, before proceeding to apply them.

Method of Application.—Having determined to apply the forceps, the same general rules should be observed as in turning, viz.: evacuate the bladder and rectum; draw the patient to the edge, or side of the bed, having previously protected it from injury, and place her either on her back with the feet supported, or as the English practitioners prefer, on her left side. The necessity and nature of the operation should always be explained to the patient or her friends, before proceeding to its performance.

The instruments should always be warmed and well anointed before using them, and some mild unguent should also be applied to the external organs, and the patient protected from exposure by a sheet or blanket thrown over her. The great importance of a *precise* knowledge of the *position of the head* should be impressed upon the mind of the practitioner, before commencing this operation.

Which blade must be introduced first?—In this country and on the continent, where the long curved forceps are used, very explicit directions are laid down for the choice of the blade. In England, where

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is on a horizontal surface, is 3·4 inches, which indicates the degree of curvature of the blade.

"The elevation of the handles near the joint, above the same horizontal line, is 1·3 (including the thickness of the blades), which indicates the extent of the angular bend in the handles."

A careful perusal of these judicious remarks of Professor Hodge, will impress the student with the advantages of the eclectic forceps, and will render any farther description of this instrument unnecessary.

the short straight forceps are employed, it seems to be a matter of indifference which is applied first, the general directions being to apply that blade first, the lock of which looks forwards. The following directions, therefore, apply to the use of the *long curved forceps.* Let the student remember, in the first place, that the forceps are to be applied perpendicularly to the transverse, and parallel with the occipito-mental diameter of the child's head. As a general rule, the *left hand,* or *male blade,* should always be introduced *first.*

Occipito-anterior position, where the vertex presents and rotation has taken place. The left hand, or male blade, is to be taken in the left hand as a writing pen is held, two or three fingers of the right hand are to be introduced between the left side of the vagina and the child's head, so that their extremities may touch the os uteri; the handle of the instrument is first raised up high in front of the woman's right groin, so as to bring the other extremity in the line of the axis of the vulva, into which it is next gently and slowly introduced *in the interval between the pains;* in proportion as it enters, the handle is by degrees brought from above downwards, and from right to left, towards the median line. The point of the instrument must be kept carefully in contact with the child's head, and *no force* used in the introduction. It is thus moved onwards, making it follow the left posterior inclined plane, gradually depressing the handle until the instrument has been placed by the side of the child's head in the direction of the occipito-mental diameter. The handle is then to be given in charge of an assistant, and the *right hand,* or *female blade,* to be taken in the right hand in the same manner as before, while the fingers of the left are to be introduced between the right side of the vagina and the child's head. Upon these, as the guide, the blade is to be introduced as before described, gradually depressing the handle till it comes in contact with and crosses the blade first introduced; the two are then to be locked, and the adjustment is completed. Care should be taken that nothing be entangled in the lock of the forceps, by carrying the finger round it.

Should the handles of the forceps, when applied, come close together, probably the bulk of the head is not included between them, and therefore, when we acted with them, they would slip.

If the handles, when locked, are at a great distance from each other, they are not accurately applied, and will probably slip. Allowance should be made, however, in these estimates, for the different dimensions of the heads of children. When the instrument is thus adjusted, a slight compression, and traction should be made in order to be sure the soft parts of the mother are not included in the grasp (which is known by her complaints), and also to bring the instrument to its proper adjustment on the child's head.

As soon as a pain comes on, begin the extraction by slowly moving the forceps from handle to handle, thus causing them to act as double levers, exerting at the same time sufficient extractive force to prevent

the opposite blade from slipping deeper into the organs, while the handles are moved to the right, or to the left.

Great care should be taken to support the perineum as the vertex emerges, and at the same time to carry the handles of the forceps upwards, towards the abdomen of the mother, causing the head to execute the same movements, as though it were expelled by the natural pains.

The woman should be allowed intervals of rest between the extractive efforts, precisely as in a natural labour, unless there be some pressing exigency for her rapid delivery; at the same time the hold upon the forceps should be relaxed, so as to remove the pressure from the head.

When the head is born, the forceps should be removed, and the labour completed by the natural powers of the woman.

In the operation just described, that is, after rotation has taken place, when the forceps are adjusted, the lock looks upwards, and the concavity of the new curve is directed towards the symphysis pubis, while the convexity coincides with the hollow of the sacrum. In every application of this instrument, the general rule is that the *concave edges should look towards the pubes, and the convex towards the hollow of the sacrum.*

In the *first position, before the rotation has taken place,* the same general rules are to be observed in the introduction. When the blades are locked they are inclined towards the left thigh, and the lock looks upwards and to the left. The same rule of traction is to be observed as before; the rotation will take place as the head advances.

In the *second position,* the adjustment is not so easy, because after the introduction of the first blade, it occupies so much of the anterior commissure of the vulva as to leave insufficient space for the introduction of the second. To obviate this, after the first, or male blade is introduced, retract it a little till it is opposite the left ischium, then give it in charge of an assistant, and introduce the female blade to its proper position; now pass the male blade up to its position under the ramus of the left pubis, and lock as before; the handles will point towards the right thigh, and the lock will look upwards and to the right. Make traction as before.

In the *occipito posterior* positions, the forceps ought to be introduced and fixed as in the former positions, only the handles must be much more depressed, and the perineum thrust back, so as to allow them to adapt themselves to the occipito-mental diameter.

If rotation has taken place into the hollow of the sacrum, as the vertex must escape first, the first movement in extraction should be to raise the handles up a little, so as to increase *flexion;* then as the vertex escapes over the perineum (which is greatly distended in this operation, and should be carefully guarded), they should be *depressed,* so that the head may extend itself backwards, as it always does in these labours. The rest of the process is completed as in natural labour.

In the *fourth* and *fifth* positions, where rotation has not taken place, the application is more difficult; the blades rather seize the head in its vertical diameter, and are brought into parallelism with the oblique as the extraction proceeds. The introduction must take place as in a first or second position, the fifth corresponding to the first, and the fourth to the second. In these positions the forceps ought to be so placed, that the concave edge may look forwards, and it is allowable to rotate the vertex into the hollow of the sacrum, provided all hope of bringing it to the pubes has failed.

There is one position of the child's head in which it is recommended to introduce the *right hand*, or *female blade* first, viz., the *left occipito-iliac*, according to Velpeau, where the head is transverse, the occiput at the left ilium, and forehead at the right; the right hand blade is to be introduced first, and conducted with care in front of the right sacro-iliac junction, as high up as the forehead; then by the assistance of the fingers of the left hand, placed under its convex edge, and in concert with the right hand, move it from behind forwards, and from right to left, until its concave edge is turned towards the left iliac fossa, and the blade has arrived upon the right parietal protuberance. The handle, strongly depressed, is then given to an assistant, who holds it against the woman's left thigh.

The left branch is held in the left hand, and passed up along the posterior part of the pelvis, until its point is above the superior strait, and the pivot even with the mortice that is in the other branch. After having joined them, and dislodged the head, if it be still in the superior strait, and forced the occiput to descend into the excavation, provided it were not already there, the concave edges of the instrument are gradually brought to the front, and the remainder of the operation is conducted as in the occipito-pubic positions.

Dr. Meigs describes a similar operation, when the head is transverse, but lower in the pelvis, with the vertex resting on the left ischium, and the forehead on the right.

"When the instrument has grasped the head in this position, the handles will project very much towards the left thigh in abduction; but if we introduce the male blade first, inasmuch as its handle will project towards the left thigh, it will occupy all the space on that side, and prevent the insertion of the second branch, for there is no place in which to depress the handle. To avoid this difficulty, take the female blade in the right hand, and introduce it into the posterior and right side of the vagina, causing its point to sweep over the face to the right side of the head, behind the pubis, leaving the handle to project towards the left thigh. Next take the male blade into the right hand, and turning the concave edge of the new curve downwards, insert the point into the right side of the vagina below the female branch. Let the fœtal face of the clam apply itself to the convexity of the head, and slide it onwards, and in proportion as it enters, make it sweep round the crown of the head towards the back of the pelvis. In effect-

ing this, the handle comes gradually down as the clam gets on the left side of the cranium, and at last the lock is found where it ought to be, viz., under the upper or female blade, with which it is then locked."

Having ascertained that the head is properly grasped, the attempt may be made to rotate it, and the latter stage of the operation will be the same as already described.

Right occipito-iliac position.—The only difference between this and the left occipito-iliac position is in the application of the forceps, in doing which the left blade is applied first.

The forceps are sometimes necessary in *face presentations.* In these cases they may be applied to the sides of the head, as in the preceding. In those examples in which the chin comes to the pubis, the method of application is the same as when the vertex is at this point; but in those in which the forehead is at the pubis, the handles must be very much depressed at first, as well as in the occipito-posterior positions; as the case proceeds they must be strongly elevated, so as to draw the chin down to the fourchette, over which it must slip. As soon as the chin is free the handles must be allowed to descend again, whilst the traction is continued until the head is born.

In cases of *locked* or *impacted head*, instead of applying the forceps to the sides of the head, one blade is passed over the face, and the other over the vertex, for this reason: it generally happens when the head is thus locked, it is in its transverse, or bi-parietal diameter, one parietal protuberance being held at the pubis, and the other at the projection of the sacrum; there is not space enough, therefore, at these points to admit the blades, and if they are to be applied to the head, it can only be on those parts that are free from great pressure, as the face on one side, and the occiput on the other. After applying the forceps in these cases, they should be well pressed together, to prevent their slipping when the traction effort is made. The motion from handle to handle, assisted by the traction, will generally be sufficient to disengage the head, after which the forceps should be removed.

Lastly, in pelvic presentations, when the trunk is delivered, and the head detained, the method of proceeding is as follows: if the face is in the hollow of the sacrum, the body, wrapped in a napkin, should be raised upwards, and held in a position nearly perpendicular; then the left branch is introduced and applied to the head, from the chin to the vertex, afterwards the right is adjusted, following the same rules as when the head descends first.

If, however, the *occiput* is in the hollow of the sacrum, and it cannot be turned to the front of the pelvis by manual assistance, the child should be carried back over the perineum as far as can be done with safety to its neck, and the forceps introduced in front of its body, as before. In extracting the head, we should endeavour to act with such force as to cause the chin and forehead to emerge under the arch of the pubis.

In all cases the trunk is to be turned towards the direction in which

the occiput looks, and the forceps introduced along the sides of the head, in such a way that the concavity of its edges may be towards the front, or brought there in the progress of the operation.

Under whatever circumstances the forceps are applied, the extraction should always be performed in the line of the axes, and always *with gentleness.*

THE VECTIS, OR LEVER.

A just idea of this instrument will be had, by considering it as one blade of the *forceps*, a little lengthened and enlarged, with the handle placed in a direct line with the blade, that is, without any lateral curvature.

The general conditions and circumstances of labour before stated as requiring and allowing the use of the forceps, will hold equally good when the vectis is intended to be used. Three modes of using this instrument have been suggested; either as a lever of the first order, or as an antagonist to the left hand introduced into the pelvis, or as a simple tractor: the last is considered the only safe method. If used as a lever of the first kind at all, the fulcrum should be made by the hand of the accoucheur, and *not by the soft parts of the mother.*

In the second method, it is evident that if there be sufficient room in the pelvis for the introduction of the fingers of the left hand, there can be but little necessity for instrumental assistance.

In the third method, that proposed by Dease, of Dublin, the instrument is introduced as a single blade of the forceps would be, the point is carried fully over the child's head, and the handle grasped tightly, and held firmly by one hand, while the shank of the instrument is embraced by the other, and a movement, that of steady traction downwards, should be given by that hand which embraces the shank, thus converting the instrument into a lever of the *third* order. (Fig. 318.)

The same posture and preparatory arrangement of the patient should be made, as in forceps cases; and in the same manner, the traction is to be made during a pain. This instrument may be used to correct malpositions, and to assist rotation and flexion.

THE FILLET OR NOOSE, AND BLUNT HOOK.

The first consists of a strip of strong cloth, silk, or leather, formed into a running noose, and intended to be introduced over the head in whatever way can be most easily accomplished; and this done, the loop is tightened, and extraction effected by main force. Its use is now discarded in head presentations. Some persons, however, still make use of it to effect extractive force upon the ham, groin, or axilla; but, as the *blunt hook* answers a better purpose, and is more easily applied, it is now rarely used, except to confine the hand in shoulder presentations, where turning is necessary.

Fig. 318.

The *blunt hook* is applied to the groin in breech cases, or to the axilla where the shoulders are delayed; it is also sometimes used to produce flexion in breech cases, when the body is born and the head detained. In these cases it may be tried first in the mouth; if that fail, it may be fixed upon the lower edge of the orbit.

CRANIOTOMY.

This operation is demanded at times on account of either mother or child; on account of the mother, in consequence of deformed pelvis; on account of the child, in consequence of the disproportionate size of the head, tumours of the chest or abdomen; or both these conditions may occur at the same time.

Uniform smallness of the pelvis, or contraction of its brim, or of any part of its cavity or outlet, are, of course, most serious obstacles to labour. Unless timely aid be given, not only may the child be destroyed, but the mother's vital powers may be exhausted, in ineffectual parturient efforts, and the most serious consequences result to the soft parts, from the long-continued pressure upon them, such as sloughing, apertures from the vagina into the bladder or rectum, and other accidents, rendering her miserable for life.

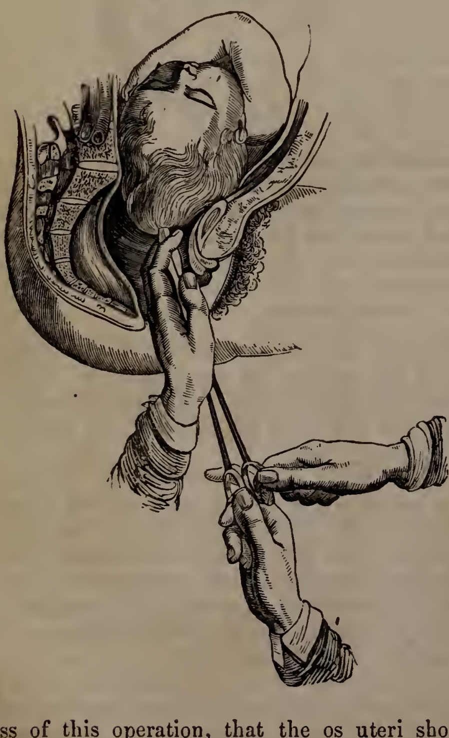
Care should be taken, therefore, never to delay assistance until the woman has become exhausted. Shivering, or vomiting, dry brown tongue, and a pulse above 100, show a necessity for active interference.

The object of the operation of craniotomy is to terminate the labour with safety to the mother in cases where, from the disproportion between the size of the fœtal head and the pelvis, a living child can neither be expelled by the natural powers, nor extracted by the forceps; it being always understood that *the distortion is not so great as to prevent the extraction of the child when mutilated.*

According to most authorities, whenever the bones of the pelvis approach much nearer to each other than three inches in the antero-posterior diameter, it is unequal to the transmission of the skull entire; and unless there be at the superior strait an antero-posterior diameter of an inch and a half with a transverse of three, it would be useless to attempt to deliver *per vias naturales*, even after the head has been reduced in size.

In some cases, where the sutures are very loose, the evacuation of the brain is often sufficient, as the bones of the cranium collapse so much by the pressure of the womb that the child may be expelled by the natural powers. But it is presumed in this case that the pains are strong and frequent. Should this not be the case, the brain must be evacuated, and extracting force applied.

Fig. 319.

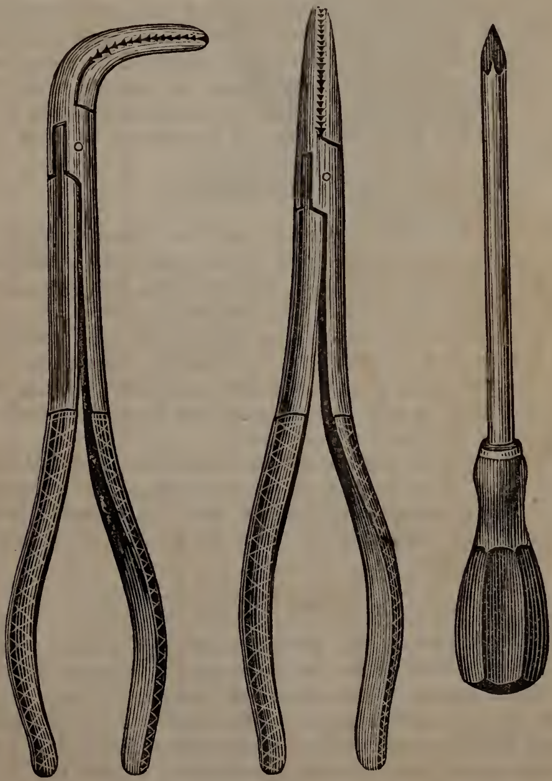


The instruments required are of two kinds, — the one to perforate the skull, and the other to extract, after the necessary diminution is effected. The first are called perforators, the second, crotchets, blunt hooks, craniotomy forceps, &c.

Mode of operating.—It is not absolutely necessary for the success of this operation, that the os uteri should be *entirely* dilated, although the wider the orifice is, the less danger will there be of injur-

ing that organ. The rectum and bladder having been previously emptied, the woman is to be placed in the same position as in forceps operations. The perforator should then be carefully applied upon the groove between two fingers of the left hand, previously introduced, and placed upon the part of the head which it is proposed to open. It must now be passed forwards with a semi-rotatory motion until it penetrates the bone; if the *scissors* are used, the handles should be separated as widely as possible. The cutting edges are then to be placed at right angles to the first incision, and again separated, so as to make a crucial opening. The instrument should now be passed into the

Fig. 320.



skull, and the brain broken up, after which it (the instrument) should be withdrawn. (Fig. 319.) Then the crotchet should be introduced in the same manner, and fixed upon the inside or outside of the head,

and extraction practised, being very careful to guard the soft parts of the mother.

If the head cannot be delivered in this manner, recourse must be had to the craniotomy forceps, and the bones broken up and extracted in pieces. Sometimes the forceps may be used advantageously, where the crotchet cannot. There are a variety of instruments recommended in the performance of this operation: in the first stage, Smellie's scissors, and their modification by Holmes; an ordinary bistoury wrapped near to the point; the ordinary trocar; &c. In the second, the sharp crotchet; the blunt hook; the bone forceps of Dr. Davis; the cephalotribe of Baudelocque, jr.; the straight and curved forceps of Dr. Meigs, &c. (Fig. 320.)

After treatment.—The nervous shock will be best treated by quiet, small doses of opium, and moderate stimulation. The condition of the vagina and uterus should be carefully watched and occasionally injected with warm water. If symptoms of inflammation arise, they should be met promptly by venesection, leeching, calomel, and opium. In other respects, the patient should be treated as after a natural labour.

CÆSAREAN OPERATION.

When from any cause the antero-posterior diameter of the superior strait, or the transverse diameter of the lower, is not more than $1\frac{1}{2}$ inches, there is no possibility of delivery "per vias naturales," and it becomes necessary to resort to the Cæsarean operation.

The conclusions that have been derived by Dr. Churchill from a careful examination of statistics are, "that in cases where we cannot deliver the patient by any other means, and when, consequently, both mother and child would inevitably die, we may afford each a chance by performing the *Cæsarean section.*"

The best period for operating is at the commencement of the labour, provided there be no doubt as to the necessity. The strength of the woman is then unimpaired; she can bear the operation better, and runs less risk of inflammation. For the method of performing this operation, see *text-books.*

PROLAPSUS OF THE CORD,

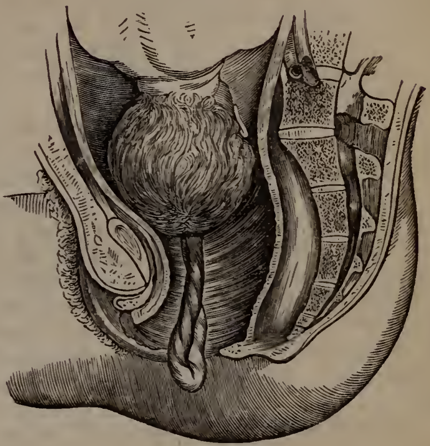
Whenever it occurs, may become a cause of preternatural labour. It may be produced in various ways, as, for instance, by transverse presentation; by over-distension of the uterus by a large quantity of liquor amnii; by sudden rupture of the membranes, and a gush of the contained fluid; by presentations of the feet or knees, the lower portions of the uterus not contracting sufficiently around the child; and by excessive length of the cord. (Fig. 321.)

The *prognosis* is, of course, unfavourable, the child being very liable to perish from asphyxia produced by pressure upon the cord.

Treatment.—Various expedients have been resorted to, in order to

replace the cord, none of which have been entirely successful. It has been proposed to push it up beyond the brim and hold it there till the head has engaged; or to hook it over the limbs of the child; or to enclose it in a little bag attached to a catheter or slender rod, then return it, withdraw the rod, and leave the bag and cord in the uterus. If, however, the head has descended, and the parts are in a favourable condition, it is better to use the *forceps*. If the woman has had children, the pelvis is roomy and the soft parts dilated, and the presenting part not descended too low, the child may be turned. Should the cord have ceased to pulsate, we need not interfere.

Fig. 321.



UTERINE HEMORRHAGE.

There are three varieties of hemorrhage treated of by obstetrical writers, viz.: *accidental; unavoidable;* and *hemorrhage after delivery*. The first generally occurs before or during labour, and arises from a partial and accidental separation of the placenta, which is generally in its usual position.

The *immediate cause* of the flooding is the separation of some portion of the placenta from the womb, and laceration of its vessels; the *remote cause* may be undue muscular exertion, blows, falls, mental excitement, straining at stool, general plethora, &c.

Diagnosis.—This variety of hemorrhage is distinguished from that which depends on implantation of the placenta over the cervix uteri by these circumstances: the os uteri may be felt on examination to contain nothing but the bag of waters: that the hemorrhage occurs during the interval of the pains, and is arrested by the uterine contractions; and that we can generally make out some definite cause for accidental hemorrhage, and its occurrence is irregular.

When the blood which is poured forth from the uterine vessels on the separation of the placenta, is at once discharged externally, the nature of the case is clear. But it may happen that the blood may be poured into the bag of membranes, or between the membranes and

the womb, without appearing externally, and may thus prove fatal, without the practitioner being aware of the danger.

This condition of things may be suspected, if, towards the end of pregnancy, the patient is subjected to any of the above causes that may produce hemorrhage, and if she complains of dull aching pains in the back, tenderness of the womb, with, perhaps, obvious swelling at some part of it, together with faintness, and the constitutional signs of loss of blood.

Treatment.—If the patient has not arrived at her full time, the hemorrhage is not profuse, and the os uteri undilated, there is no immediate danger. She should be placed in a horizontal position on a hard mattress, and lightly covered; cold applications to the pubes, or cold enemata, should be used. Internally, the infusion of rose leaves and aromatic sulphuric acid, or acetate of lead and opium, should be administered.

Should these measures not succeed, recourse may be had to the *tampon.* It should be remembered, however, that this instrument should *never* be employed when the uterus is *empty*, as the blood might collect within the cavity till the woman perished from the loss.

Should these means fail, there still exists another, viz.: *rupturing the membranes* and allowing the liquor amnii to escape. As soon as this done, the uterus contracts, compresses the orifices of the bleeding vessels, and thus arrests the hemorrhage.

Should the contractions not come on, the organ may be stimulated by the administration of ergot, and friction over the abdomen. The os uteri is generally so relaxed by the hemorrhage as to be very dilatable. It has also been proposed, if all these fail, to introduce the hand, turn the child, and thus terminate the labour.

The placenta is usually expelled immediately after the child; if it be not, it is much better to extract it, and secure a firm contraction of the uterus, than to allow the hemorrhage to continue.

If the patient's strength is much exhausted, stimulants should be used, and nutritious articles of diet exhibited. It is generally considered advisable to keep down the reaction that succeeds excessive hemorrhages, by the administration of opium, combined, if necessary, with some stimulants. The patient should be kept in a strictly horizontal position till all danger of a recurrence is past.

UNAVOIDABLE HEMORRHAGE.

Placenta prævia; placental presentation.—The hemorrhage which results in this case is the necessary and unavoidable consequence of the dilatation of the os uteri, by which the connexion between the placenta and uterus is separated; the greater the separation, the greater the hemorrhage, as the labour advances. The placenta may be situated partially, or entirely over the os uteri. (Fig. 322.) The *cause*

Fig. 322.

of the hemorrhage is the separation of the placenta from the cervix uteri, and the consequent exposure of the mouths of the bleeding vessels.

Symptoms. — The first discharge generally occurs from about three to five weeks before labour commences; the amount varies, but is generally slight at first and unaccompanied by pain. It returns again after a week or so, and without any apparent cause, and thus comes and goes till the end of gestation. With the first sensible contractions, the flooding occurs more profusely, and is seen to increase *during* each pain. An internal examination is necessary to discover whether the implantation be complete or not.

Diagnosis. — This variety of hemorrhage is distinguished by the fact, that it usually begins without evident cause, and that it is increased *during* a pain; a per vaginam examination also reveals the presence of the placenta, which is distinguished from a clot of blood by its being firmer and not breaking down under the finger. If it only partially covers the os uteri, its edge will be felt continuous with the membranes, and through the latter the presentation may perhaps be felt.

Treatment. —If the hemorrhage is slight and the term of gestation not completed, palliative measures should be tried as before described. If so profuse as to demand interference, there is no hope of a natural termination, unless the pains be so violent as to force away the placenta before the child. This, however, is so rare as not to justify waiting. The only alternative is to turn and deliver as quickly as possible. It fortunately happens that the continued bleeding so softens the os uteri as to render it speedily dilatable.

The hand is to be introduced in the usual manner, and insinuated between the os uteri and the placenta, on that side on which the placenta is believed to be thinnest; the membranes should then be ruptured as high up as possible, and the feet seized and brought down When the body of the child is in the pelvis it will act as a tourniquet,

and compress the bleeding vessels. Nevertheless, the labour should be terminated as early as possible.

Some authors recommend that the hand should be pushed *through* the placenta—a thing much more difficult to effect. The placenta should always be delivered as quickly after the child as possible, and every care taken to prevent a recurrence of the hemorrhage.

Some authors recommend that if the os uteri be undilated when the hemorrhage comes on, the *tampon* should be used till dilatation takes place. This has been objected to, on the ground, that it prevents the attendant from knowing when the os uteri is dilated or dilatable, and thus valuable time is lost.

If the feet present, it is more favourable, as the operation of turning is rendered easier. If the placenta is only attached to the edge of the os uteri, and the pains are active, it should be treated as a case of accidental hemorrhage, by rupturing the membranes. The pressure of the head whilst dilating the os uteri will close the mouths of the bleeding vessels with the placenta, and so arrest the flooding till the child is expelled.

Drs. Simpson, of Edinburgh, and Radford, of Manchester, recommend that instead of *turning* in these cases, the whole placenta should be *detached* and *extracted* if possible, before the child. The following are Dr. Simpson's conclusions, based on the examination of a large number of cases.

1st. That the complete separation and removal of the placenta before the child, is very seldom followed by any great hemorrhage.

2d. That, on the other hand, the previously existing hemorrhage almost always ceases from the moment the placenta is *perfectly* and completely detached from its connexions with the uterus.

3d. That the cessation of the hemorrhage is explicable, not on the idea that the descending head of the child acts as a plug or compress upon the exposed orifices of the uterine sinuses, but on the mutual vascular economy of the uterus and placenta, and the circumstance that the hemorrhage principally comes from the partially detached surface of the latter. The practice has been condemned by other eminent authorities, and it is recommended, even if it be adopted, to seize and bring down a foot if it can be readily found; if it be determined not to turn, it is also recommended to give a scruple of ergot at the moment of separating the placenta, so as to bring on early uterine contractions.

Hemorrhage after delivery.—The discharge in this case also proceeds from the mouths of the vessels exposed by the separation (either partial or complete) of the placenta. A certain amount is lost after the birth of the child; it is only when it becomes so profuse as to threaten serious consequences, that interference becomes necessary. It may occur after the escape of the head, while the body is retained; immediately after delivery; or at the interval of ten or twelve days after.

The hemorrhage may arise from *inaction* of the womb; from an ab-

sence of that contraction which is the only safeguard. The uterus is felt large and flabby in the abdomen; the pulse becomes weak and tremulous; the patient restless; there are constant and deep sighings and groanings, and frequent syncope, dimness of sight, and ringing in the ears, and even convulsions. These symptoms, together with the escape of the blood, will be sufficient to establish the diagnosis.

Treatment.—In every case, the indication is to *make the womb contract.* This may be done in various ways, viz., by friction to the abdomen; by the application of cold to the genitals, or abdomen; by grasping the womb through the abdominal parietes; at the same time ergot should be administered to the same end. If these means fail, the hand should be introduced into the cavity of the organ, with the hope of exciting contraction. It has also been recommended to introduce ice into the uterus; or a freshly cut lemon, and then to squeeze out the juice upon the internal surface.

Among the internal remedies are, acetate of lead and opium; alum; and magnesia. Pressure upon the abdominal aorta, and ligatures upon the limbs, are highly praised by some authors. Velpeau recommends the application of a sinapism between the shoulders as a revellent. Dr. Radford recommends galvanism as a powerful excitant of the uterine muscular fibres.

The hemorrhage may, however, be attended with partial adhesion of the placenta to the uterus, with an irregular spasmodic or *hour-glass* contraction of the latter organ. In this case, having placed the left hand on the abdomen, so as to grasp and steady the womb, introduce the right hand, in a conical form, gently through the constricted portion of the womb; separate the placenta, and then the contractions of the uterus will probably expel the hand and placenta together.

Fig. 323.

The operation of transfusion has been recommended and practised by Dr. Blundell in cases of extreme danger from loss of blood, and has proved successful in fourteen cases, although it has failed in an equal number.

The patient should be kept in a strictly horizontal position, and if syncope occurs, the head should be lowered and the feet elevated, so as to allow the blood to flow to the brain. Stimulants should also be administered, and the room kept cool and well ventilated. The after treatment is the same as in the cases already described.

PUERPERAL CONVULSIONS.

There are three varieties spoken of by obstetrical writers, viz., the *hysterical*, the *epileptic*, and the *apoplectic*. The first occurs gene-

rally during the early months of gestation, and in females of a nervous or hysterical constitution. It is distinguished by the absence of insensibility, and frothing of the mouth, and the convulsive movements of the lower jaw. There is no stertorous breathing, and but slight contortion of the body; although in many cases, the muscles of the back are violently contracted, a symptom which is looked upon by Dr. Dewees, as pathognomonic of this form. The paroxysms often terminate in screams and tears, and the discharge of a large quantity of limpid urine.

Treatment. — If there be a quick, full pulse, or headache, venesection may be practised, or a few leeches applied to the temple. In general, the attack is relieved by antispasmodics, such as musk, camphor, valerian, or assafœtida. Cold water poured from a height upon the head will often break up the paroxysm. When it has ceased, a small dose of opium should be administered.

Epileptic convulsions. — The symptoms resemble those of an ordinary epileptic attack, and the patient often has premonitions of what is coming, from the presence of pain in the head, ringing in the ears, obscure or partial vision, loss of sensation, rigors, nausea, &c. The *aura epileptica* is seldom felt.

The *attendant symptoms* are, a turgid purple condition of the face; convulsive movements of the face and whole body; foaming at the mouth; repeated and sudden closure of the under jaw, by which the tongue is often dreadfully bitten; the respiration is at first irregular, and being forced through the closed teeth, and the foam at the mouth, has a peculiar hissing sound, which, once heard, can never be mistaken; the pulse is quick, full, and hard at the beginning, but afterwards becomes small and scarcely perceptible; the urine and fæces are often discharged involuntarily.

This fit lasts for a time varying from five minutes to half an hour, and then gradually subsides; the pulse often becoming calm, and the patient conscious; or she may remain in a state of complete coma with sibilant or stertorous breathing; the more profound the coma, the greater the danger.

The calm is generally short in duration, being often followed by a recurrence of repeated paroxysms and intervals.

Puerperal convulsions may come on either before, during, or after labour. When they occur before labour, uterine contraction is very apt to come on synchronously with the fit, and the child is born dead. When they occur during labour, the latter runs nearly its natural course, and the fits are synchronous with the pains, though not recurring with each. When they occur after labour, they generally take place from two to four hours after the child is born, and are attributable to some injury received by the brain and nervous system during the parturient effort.

The *causes* are generally a loaded state of the stomach or bowels; intemperance in eating or drinking; fright; and in most cases, an

accumulation of blood in the brain during the violent expulsive efforts. Primiparæ are more frequently attacked than multiparæ. They are frequent attendants upon the œdematous condition in pregnancy, and may be anticipated when this occurs. The urine is often albuminous and deficient in urea.

Treatment. — The first indication is to protect the brain from the effects of an accumulation of blood. This should be done by taking away blood, in a full stream, from the arm, or temporal artery, and repeating it if the paroxysm continue. This may be followed by cups or leeches to the temples and back of the neck; there is great tolerance of bloodletting in this disease.

A strong purgative should next be given (such as calomel and jalap), and its operatiou assisted by stimulating enemata. It has also been recommended to combine tartar emetic with the purge, or to give it alone, in divided doses, after the bowels are moved. The head should be shaved, and cold applications made to it.

In regard to the *use of opium*, most practitioners are in favour of it when judiciously used. If it be given in the commencement of the attack, when the patient should be bled, it can only hasten the fatal result. But if the fits continue, *especially after delivery*, with signs of great irritation and exhaustion, it may be given with the hope of deriving benefit, remembering that depletion should always be premised.

Should the process of labour or parturition be interfered with? If the convulsions occur during gestation, the uterus should not be interfered with. Should they occur at the commencement of labour, the propriety of interference may be questioned; the safest plan is merely to rupture the membranes (provided the os uteri is dilated or dilatable), which sometimes hastens the progress of the labour. *Version* has been condemned. When the head has descended into the pelvis, and there is sufficient space, the *forceps* should be used. The attempt should be made during an interval of the paroxysm; should the fit recur at this time, the blade should be withdrawn, for fear of injuring the mother.

Should the head of the child be fixed in the pelvis, so as to be immovable with the forceps, it may be necessary to open the head. Before this is done, however, all the attendant circumstances should be carefully weighed; the child may be alive; the labour, if left to itself, may terminate naturally; and lastly, even if terminated by art, the fits may not necessarily cease.

Apoplectic convulsions. — Generally speaking, in this form there is little or no convulsions, no distortion of the face, and no frothing at the mouth; the muscles are flaccid and powerless; the respiration is stertorous, the patient is insensible, and there is generally no repetition of the paroxysm.

The attack is generally preceded by headache, ringing in the ears, total or partial blindness, and flushing of the face. The pulse is full,

slow, and laboured during the attack, and the pupils insensible to light. This form almost always occurs during labour, and is caused by the violent strain upon the cerebral vessels during the expulsive efforts.

Treatment. — Bloodletting in a full and copious stream, either from the arm, jugular vein, or temporal artery. This should be repeated if needful, or followed by local depletion, in the form of cups or leeches. If the patient is benefitted by it, the head should then be shaved and ice applied, and the bowels freely evacuated.

If this variety occur during labour, and the uterine action be suspended, the patient should be delivered as speedily as possible, in order to save the child; for this purpose, if the head be within reach, the forceps should be applied. The after treatment of all these cases requires the greatest watchfulness and quiet. Should the patient become maniacal, all sources of irritation, within and without, should be removed, the patient kept quiet in a dark room, and under the influence of tartar emetic.

PUERPERAL FEVER.

This malady has received various names, such as *childbed fever*, *puerperal fever*, *peritoneal fever*, *puerperal peritonitis*, *low fever of childbed*, &c.; by some it has been considered as a fever dependent on local inflammation, by others as a blood disease. Each author who has written upon the subject, has adopted a classification in accordance with his own views and experience; it would be impossible, therefore, in a work of this kind, to give a synopsis of *all*. "The student is liable to be deceived, if he grounds his ideas of this malady solely on the observations of one or two writers, especially those who have witnessed epidemics as they have appeared in hospital practice, however graphic the representations may be; because scarcely any two have resembled each other; and because the symptoms in all cases are much modified by the temperature and other qualities of the atmosphere, the season of the year, the localities in which the disease appears, and several external circumstances, independently of the constitution of the patient herself." [1]

There may be said to be *four* principal varieties of this disease. The *first* and most common variety is characterized by pain and tenderness in the abdomen, preceded by a chill, and accompanied by a hot skin, rapid pulse, and sometimes profuse perspiration. In this form the uterus and its appendages, or the peritoneum, receive the greatest force of the blow.

The *second form* assumes the character of a mild typhus, accompanied by intestinal irritation. It is ushered in by rigors, followed by a hot fit; and succeeded by nausea and vomiting or diarrhœa, with most offensive evacuations. The tongue, at first loaded and white, soon

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[1] Ramsbotham, p. 415.

becomes preternaturally red, as in those affected by chronic dysentery. The skin is dry and hot, and of a dusky yellow hue; the mind is unsettled, without being absolutely delirious; the debility is extreme, and the limbs tremulous. In some cases these symptoms are followed by acute inflammation of some important organ, or of the joints, softening of the womb, suppuration of its lymphatics, or veins. There is usually suppression of the milk, and sometimes of the lochia.

In the *third variety* the main mischief seems to be expended on the nervous system; there is great delirium, agitation, and sense of impending death. This form is liable to be followed by fatal syncope and coma, and may supervene on either of the others.

The *fourth* and worst form of puerperal fever affords the most extensive evidence of the diffusion of a poison over the system through the blood, and presents the most perfect analogy with scarlatina maligna. Shivering, and abdominal pain, are followed by rapid exhaustion, quick pulse, glassy eye, and dusky skin. There are often pain in the chest, husky cough, laborious breathing, and other evidence of inflammation of the lungs, which after death may be found gangrenous. Abscesses of the joints and cellular tissue; phlebitis, and gangrene of the intestines, are among the ravages of this most fatal malady.

There are a few *general symptoms* which may be added to those mentioned above as characterizing the different forms. The pulse is always accelerated, ranging from 110 to 140, or 160; in the inflammatory form it is full and hard; in the adynamic, weak and small; pain is not uniformly present, though most generally; there is great tympanitis, and generally constipation. The lochia and milk are usually suspended; the urine is suppressed, or voided with great pain; tormina and tenesmus are present; and there is often a vomiting of yellow or green bitter matter, and in the last stage a discharge resembling *black vomit.* The intellect is often undisturbed to the last, though the patient often takes a great aversion to her infant.

Numerous *causes* have been laid down as productive of this disease: among the predisposing, are atmospheric vicissitudes, depressing passions, unhealthy residences, dissipation, bad diet, &c. Among the exciting are, epidemic influences, intestinal irritation, retained placenta, difficult labour, suppression of lochiæ and lacteal secretion, and *contagion.*

There are many who look upon this as a *blood disease,* who believe that puerperal fever originates in a vitiation of the fluids; and that the causes which are capable of vitiating the fluids are particularly rife after childbirth; and that the various forms of puerperal fever depend on this one cause, and are deducible from it. Others, on the contrary, believe that the primary impression is made upon the nervous system.

The *treatment* must vary according to the form of disease we have to contend with. In the first, or inflammatory form, instant recourse must be had to bloodletting, which must be pushed to the extent of

syncope, if necessary. The abdomen should then be covered with leeches, which are to be followed by hot fomentations. The bowels should also be freely opened with a purgative, after which calomel and opium should be administered, with the view of producing their constitutional effects.

In the *second form*, bleeding, except in the early stage, will be generally improper, and even then should be restricted to plethoric patients. The principal reliance must be placed on purgative medicines, as salines and mercurials. A full dose of calomel should be exhibited, and followed by a purgative; after free evacuation, calomel and opium should be administered. After the bowels are unloaded, purgation should cease, as it rather causes depression; mercurials and salines, or tonic stimulants and carminatives, should be used, according as the disease shows marks of excitement or depression. In the low form, bark, camphor, or ammonia appear to be particularly indicated.

In the *third* or nervous form, warm purgatives should be administered, or laxative enemata, after which a few doses of opium should be exhibited. Bloodletting is generally uncalled for.

In the *fourth* variety, the two indications are: *First*. To attend to the local lesions. *Second*. Never to forget that these are not the disease, but merely the effect of a more diffusive, though concealed cause, to act on which our remedies should be directed. The rationale of the treatment, therefore, consists in the exhibition of such remedies as will act on the cause, and such as will alleviate or remove the local affections; taking care that in our attempt to effect the latter end, we do not so act on the constitution as to give additional energy to the more deadly power of the concealed cause. (Ferguson.) In the early stage, leeches, blisters, calomel, and opium, &c., should be used as required: and in the latter stage, stimulants and tonics.

MILK FEVER.

The milk fever generally begins on the third day after delivery, sometimes on the first or second, or not until the fourth, fifth, or sixth. It is ushered in with chills, headache, pains in the back and limbs; the pulse, at first small and hard, soon becomes developed, and the skin hot; the breasts grow hard, swelled, and painful in a few hours, so as to prevent the motion of the arms. This condition of things is followed by a sweat, and the fever abates in the course of twelve or twenty-four hours, and the secretion of milk is established; the breasts, however, remain tumid and painful much beyond this period, especially in women who do not give suck. The lochia, too, are often suspended or diminished during this time.

Treatment.—The bowels should be freely moved by the administration of a saline cathartic, or oil. If the fever runs high, a small bleeding should be practised. If the breasts are painful to the touch, they

should be covered with warm emollient poultices, and if not relieved by this, a few leeches should be applied to them.

These means are important to prevent the formation of a mammary abscess. The breast should not be allowed to fill with milk, but should be drawn either by the child or artificially, as often as it becomes distended. Should suppuration unfortunately take place, the pus should be evacuated as soon as possible, and a warm poultice applied. If sinuses remain from the burrowing of pus, compression should be made upon the gland by means of adhesive straps. If a milk fistula should be the result, the orifice should be filled with a tent, and the wound allowed to granulate from the bottom.

INVERSION OF THE WOMB.

The inversion may be either partial or complete. *Partial inversion* may be known by the absence of the fundus behind the pubes, and the presence of a large solid tumour in the vagina, accompanied by profuse hemorrhage, intense pain in the pelvis, violent tenesmus, vomiting, fainting, cold, clammy sweat, and feeble or imperceptible pulse.

Complete inversion is recognised by the presence of a reddish, livid tumour, filling the vagina, and protruding beyond it, resembling in shape the uterus after delivery. The os uteri may be felt at the superior extremity of the tumour, forming a kind of circular thickening at its apex, and the uterus is wholly wanting in the hypogastric region.

Causes.—It may occur spontaneously in atony of the uterus, or from irregular contractions. Violence in extracting the placenta; shortness of the cord, delivery in the upright position, tumours of the uterus unconnected with parturition, have all been mentioned as causes of this accident.

Treatment.—By some it is recommended to compress the tumour and pass it in through the vaginal orifice, followed by the hand, which, when in the vagina, should be formed into a cone, and made to press mainly upon the fundus uteri; after a while it will be found to recede, and on being farther pressed, it suddenly starts from the hand, and the organ is returned to its natural condition.

Others advise that no compression be made; the womb should not be handled, but watching it carefully, at the moment when free from contraction, the fundus should be pressed with one finger and indented like the bottom of a bottle; when that much is effected, the reposition is sure, provided continual pressure be made: the fundus will be pushed up again through the os uteri and vagina, until the hand is found high up in the cavity of the uterus.

If the placenta be adherent, some recommend that it be reduced with the fundus; others, and the majority, that it be first removed, and then that reduction take place, as this procedure will facilitate the operation.

2 2

HAND-BOOK

OF

CHEMISTRY:

WITH

NINETEEN ILLUSTRATIONS.

(585)

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PART III.

ORGANIC CHEMISTRY.

CHEMISTRY.

PRELIMINARY OBSERVATIONS.

PHYSICAL SCIENCE, in its most extended sense, comprises the two great divisions of *Natural History* and *Natural Philosophy*. The former includes Anatomy, Zoology, Botany, and Mineralogy; the latter embraces Chemistry, Geology, Physiology, and Mechanics.

CHEMISTRY may be defined to be the science which investigates the molecular changes of bodies; or more strictly, that which treats of the laws that relate to chemical attraction.

The whole material world is subject to *Force;* this it is which produces change in bodies. Two great opposing forces appear to exist, —Attraction and Repulsion: the *cause* of either is unknown, and purely speculative. Bodies are either solid, liquid, or gaseous, according as one or other of these two forces preponderate; thus, if the molecules of a body adhere with a force called *cohesion*, so that an exterior power is required to separate them, the body is termed a *solid;* if the cohesion is only such as to allow the particles to move upon each other, it is named a *liquid;* and if the particles are kept apart by a repulsive force (supposed to be Caloric), it is denominated a *gaseous* body.

Attraction comprises several species or subdivisions, as Cohesion, Chemical Attraction or Affinity, Gravitation, Capillarity, and Endosmose.

Cohesion.—This is the attraction between homogeneous particles. It is only exerted at insensible distances, the molecules never being in absolute contact, otherwise the property of *elasticity* could not exist, since this requires space for the molecules to move in.

Chemical Attraction or Affinity.—This is the attraction between heterogeneous particles. Like cohesion, it is exerted only at inappreciable distances; in other words, apparent contact must take place; but unlike cohesion, it is always accompanied by a change of properties.

Gravitation.—This attractive force is displayed between masses, and at sensible distances. It gives weight to bodies, and it is the cause of the tendency of bodies to fall towards the earth's centre.

The great law of gravitation is, that "the attraction is directly as the quantity of matter, and inversely as the square of the distance." This law also regulates the movements of the solar system.

Capillarity.—This is the attraction exerted between liquids and solids; it has received its name from the circumstance of its being especially exhibited between liquids and fine tubes, called *capillary*, by which the liquid rises in the tube above the level of the surrounding liquid,—the height depending on the smallness of the diameter of the tube, being inversely to the latter. This is the cause of bodies being wetted when placed in contact with certain liquids, the latter being attracted to the surfaces of the former. Capillarity is not exerted equally between all solids and liquids; on the contrary, in some cases there is a positive repulsion, as between glass and mercury. The mere density of the liquid does not, however, modify the force.

Endosmose.—If a membrane be interposed between two liquids of different density, having an affinity for each other, they will intermix by passing through the pores of the membrane. But the rapidity with which the two currents are established, will be unequal, and will be modified by the membrane. The general law is, that *the stronger current is from the rarer to the denser liquid.* The term Endosmose is at present used to express this stronger current, no matter which direction it may take. It is evidently a modification of Capillarity, though it is influenced by the relation subsisting between the membrane and the surface of the liquid. The essential conditions of Endosmose are that the liquids should have an affinity for each other, and that one of them, at least, should have an affinity for the membrane.

Another physical force, frequently considered as a modification of Endosmose, is the *Diffusibility of Gases*, or the tendency of gases to commingle, even though differing in density, and separated by a porous partition. This is readily shown by taking a wide glass tube, and placing in its centre a septum of dry plaster of Paris, and then filling one side of it with oxygen, and the other with hydrogen. The two gases will penetrate the septum, though at very different rates; four cubic inches of hydrogen will pass into the oxygen side, while only one cubic inch of oxygen will pass in the other direction. According to Mr. Graham, the diffusibility of gases *is inversely as the square root of their densities;* thus, in the instance above given, the densities of hydrogen and oxygen are to each other as one is to sixteen, hence the diffusive power of the former is four times greater than that of the latter. This law is of great importance in nature, preventing the accumulation of noxious gases in any one spot, and regulating the intimate mixture of the constituents of the atmosphere.

In the process of respiration, the interchange between the oxygen of the air and the carbonic acid of the lungs is effected through *moist* membranes, which considerably modifies their respective diffusibility, on account of their different solubility in water.

Under the present head we may most conveniently notice the subject of the Physical Constitution of the atmosphere and of other gases, and the method of ascertaining specific gravity.

Physical Condition of the Atmosphere.—The proof that the atmosphere has weight is afforded in various ways, although we are not ordinarily sensible of it, as it surrounds us on every side, and is thus maintained in equilibrium. By weighing a large glass receiver before and after its contained air has been exhausted, we shall perceive an obvious difference in the weight. By placing the hand over the mouth of a small receiver, and exhausting the air from the interior, a painful pressure will be experienced from the superincumbent atmosphere. If a bladder be tied over an open-mouthed receiver, and the air be exhausted, the pressure will be sufficient to burst the bladder with a loud report. A similar result follows if a very thin glass receiver be exposed to the exhausting operation of the air-pump. All the above experiments prove that the atmosphere has weight; the *amount* of this weight is easily shown by the Torricellian experiment, which consists in filling a glass tube, forty or fifty inches long, closed at one end, with mercury, and plunging the open end in a vessel of the same liquid; the mercury will descend to about the level of thirty inches. It is kept at this height by the atmospheric pressure on the mercury in the basin. Now it is ascertained that a column of mercury thirty inches high and one inch square weighs about fifteen pounds; hence the inference that the atmosphere presses upon every square inch of the earth's surface with a weight equal to fifteen pounds. If water had been used in the above experiment, it would have risen to the height of thirty-four feet; and a fluid of still lesser density to a proportionately greater height.

The *barometer* is but a modification of Torricelli's tube. It consists of a glass tube, a little over thirty inches long, closed at one extremity; it is filled with mercury, and then inverted so as to place the open end in a small cup of mercury; the pressure of the atmosphere upon the surface of the latter sustains the mercury in the column, as before mentioned. The use of the barometer as a *weather-glass* depends upon the fact that the atmospheric pressure varies at the same place; when it is greatest, the barometer will of course stand highest, and will indicate fair weather, and *vice versâ*.

As already remarked, gases are far more elastic than either solids or liquids. The elasticity of the air, and of gases generally, depends upon the degree of pressure to which they are subjected. By the law of Mariotte, *their density and elastic force are directly as the pressure, and inversely as the volume.* Thus, one hundred cubic inches of air under any pressure, would expand to two hundred cubic inches if the pressure were reduced one-half, or contract to fifty cubic inches if the pressure were doubled.

As the height of the barometric column measures the pressure of the atmosphere, it follows that the higher we ascend, the lower will

the column fall, on account of the diminished height, and consequently the weight, of the atmospheric column. Hence the barometer is a valuable instrument for measuring the height of mountains. It has been ascertained that a fall of one inch indicates an altitude of about 922 feet; this ratio is true only near the level of the sea, for as the height increases arithmetically, the pressure diminishes geometrically. At three miles elevation, the barometer stands at fifteen inches; at six miles it reaches 7·50 inches; at nine miles, 3·75 inches, &c. The whole height of the atmosphere is believed to be about 45 miles.

The action of the common water-pump, and of the air-pump, depends solely on atmospheric pressure; the elevation of the piston, in either case, producing a vacuum which is instantly filled by the pressure of the air forcing in the fluid.

SPECIFIC GRAVITY.

By *specific gravity* is meant the ratio of the weight of a body to its bulk, or the weight of a body compared with the weight of an equal bulk of some standard, which is received as unity. In solids and liquids this standard is pure water at the temperature of 60° F.

To find the specific gravity of a liquid, it is only requisite to weigh equal bulks of that liquid and water at the same temperature, and then divide the weight of the liquid by the weight of the water; the quotient will of course be greater or less than unity, as the liquid employed is heavier or lighter than water. Now, the simplest mode of weighing equal bulks is to weigh them in succession in the same vessel, taking care to have exactly the same quantity in both cases. Another method is to employ a solid body, as the stopple of a bottle, ascertain how much weight will sink it in the given liquid, and divide this by the weight required to sink it in water; this is obviously the same as ascertaining the weights of the relative bulks of the two, since a solid body always displaces *its own bulk* of a liquid.

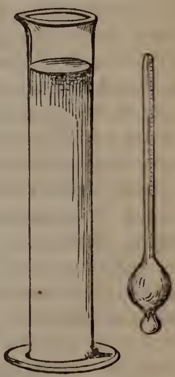
To find the specific gravity of a solid. — The principle here is precisely the same as in the case of liquids: the rule being "to divide the weight of a given bulk of the body, by the weight of an equal bulk of water; and the mode adopted is first to weigh the body in the air, then to weigh it in water; find out how much it loses by being weighed in water (which will express precisely the weight of an equal bulk of water), and then divide the first weight by this last, and the quotient will be the specific gravity. This rule is founded on the hydrostatic law, that when a solid is immersed in a fluid, it loses a portion of its weight exactly equal to the weight of the portion of fluid displaced; that is, equivalent to the weight of its own bulk of that fluid. If the solid be lighter than water, as in the case of cork, its specific gravity may be found by suspending a small glass funnel from a scale-beam, and counterpoised so as to be just below the surface of the water; the lighter body is then to be thrown up under the funnel, which will, of course, destroy the equilibrium, and elevate

the funnel. Ascertain how much weight will counteract the buoyancy of the light body, add this to its weight, and divide its weight by the sum; the quotient must, of course, be less than unity.

Another method of finding the specific gravity of a solid body lighter than water, is first to weigh it in the air, then to attach to it a piece of metal heavy enough to sink it, and weigh the whole as before, and afterwards weigh the whole in water. The difference between the two last weighings gives the weight of the bulk of water equal to the whole mass. But we wish to find the weight of the bulk of water *equal to the light body:* this is done by subtracting from the last-mentioned weight the weight of a bulk of water equal to the piece of metal. Finally, we divide the absolute weight of the light body in air by the weight of its equivalent bulk of water, as in ordinary cases, and the result will of course be less than unity.

Hydrometers are instruments employed for ascertaining the specific gravity of liquids. They consist of hollow metallic balls, attached to a thin stem, and having a weight beneath, to keep it erect. The use of the hydrometer is very simple. The liquid to be tried is put into a narrow vessel, and the instrument floated in it. It is obvious that the denser the liquid, the higher will the hydrometer float; and *vice versâ;* the point on the graduated stem will then express the specific gravity.

Fig. 324.



To ascertain the specific gravity of gases, it is only requisite to fill a globe of known capacity with the gas, then to weigh it, and to divide the result by the weight of the same bulk of atmospheric air, which is the standard, or unity, for gases. It must also be remembered that the specific gravity af gases is influenced by their *purity*, their *hygrometric condition*, the degree of *pressure* to which they are subjected (their bulk being inversely as the pressure), and their *temperature.*

PART I.

IMPONDERABLE SUBSTANCES.

SECTION I.

CALORIC.

The term *Heat* is used in two different senses: one signifying the sensation conveyed by a heated body; the other, the material *cause* of heat; this latter is called *caloric.* The effect of the union of caloric with ponderable matter is to communicate a repulsive property to its different molecules, overcoming its cohesion; and causing, successively, expansion, fusion, and vaporization. Caloric is usually spoken of under the two heads of *sensible*, or that which is evident to the thermometer, and *latent*, or that which is insensible to the thermometer. *Latent heat* may be illustrated by the following experiment: — Mix a pound of water at 174°, and a pound of water at 32° together; the temperature of the mixture will be the mean of the two, or 103°; but if a pound of snow or ice at 32° be used instead of the water at 32°, the resulting temperature will still be only 32°, but the ice will have melted. Hence, in this last experiment, as much heat has been rendered latent in the melting of the ice, as would have raised an equal weight of water *one hundred and forty-two degrees.* Again, if a vessel containing water be placed over the fire, the thermometer will indicate the constant increase in its temperature up to the boiling point, 212°; beyond this point, however, provided the steam escape, the successive portions of heat received by the liquid will be entirely insensible; that is, the additional caloric will be rendered latent. This latent caloric may, however, be proved to exist, or may be rendered *sensible*, by conducting the steam into cold water, when it will be found to raise the temperature of a quantity of water ten times heavier than itself, nearly one hundred degrees; or, if concentrated in one of these parts, the rise of temperature would be nearly one thousand degrees. Hence it follows, that as much heat is absorbed (rendered latent) in producing steam, as would raise the water of which it is composed one thousand degrees, or to about a red heat, if prevented from assuming the aeriform state.

The above law is universal. Whenever a solid body becomes liquid, or whenever a liquid becomes gaseous, a quantity of heat disappears, or is rendered latent; and conversely, when a gaseous body is converted into a liquid, or a liquid into a solid, a corresponding degree

of caloric is given out, or rendered free. The amount of latent heat varies much in different substances.

On this principle, the cold produced by the various *frigorific* mixtures is explained; thus a mixture of snow and salt produces a cold of zero, in consequence of the attraction between the salt and water producing liquefaction, and thereby rendering latent a large amount of caloric. A notable depression of temperature is also caused by a simple solution of certain salts in water, as of nitre, sal ammoniac, &c. A striking example of the reverse process, or the rendering latent heat sensible by condensation, is afforded in the slaking of lime by water; here, the large amount of heat evolved arises from the water passing into a solid state, in its combination with the lime. Another familiar instance is the rise of temperature usually experienced before a snow-storm, in consequence of the condensation of the vapour into snow, thus giving out its latent heat. Latent heat has hence been denominated the *heat of fluidity*, since it is necessary to maintain bodies in the fluid condition.

EFFECTS OF CALORIC.—EXPANSION.

Expansion is one of the first effects of caloric. It is caused by the repelling power produced by the caloric upon the particles of the body. As it is opposed to cohesion, it follows that those bodies are most expanded by heat which are least influenced by cohesion; thus gases are more expansible than liquids; and liquids more than solids.

Expansion in Solids. — This may be proved, by accurate measurement of them before and after heating; — by an accurately-fitted metallic plug and ring; if the plug be heated it will be too large for the ring;—the same is shown in heating the tire of a wheel before hooping it; — it is seen also in the elongation of the metallic bar of the *pyrometer*, by heat.

Of solid bodies, the *metals* are the most expansible. Metals are not equally expansible; — lead is most so; platinum the least. If a thin, straight bar of iron be firmly riveted to one of brass, and then exposed to heat, the brass being more dilatable than the iron, forces the bar in a curve, the convex side of which is brass; if it be artificially cooled, the brass contracts more than the iron, and the reverse of the above effect is produced. The supposed exception to the general law that solids expand by heat, in the case of clay, is only an apparent one; the contraction of this substance, as seen in Wedgwood's pyrometer, by the action of heat, is due to the shrinking produced by the loss of water. Beyond certain limits solids do not expand uniformly for equal increments of heat.

Expansion in Liquids. — Liquids differ from *fluids* in not being elastic; — they are more expansible than solids, as shown by placing an alcoholic and a mercurial thermometer in the same heated substance; the alcohol will rise much higher in the tube than the mer-

cury. Liquids are not equally expansible. Nor is there any relation between their expansibility and their other properties, as density, &c. In being heated from 32° to 202°, alcohol expands $\frac{1}{9}$th of its bulk; water $\frac{1}{23}$d; mercury $\frac{1}{55}$th. The *rate* of expansion in liquids is not uniform, — it increases with equal increments of heat. There is one remarkable exception in the law that liquids expand by heat, in the case of water near the freezing point, which *expands* on being cooled below 39°—hence ice swims on water; this expansion is due to a new arrangement of its particles in the act of freezing.

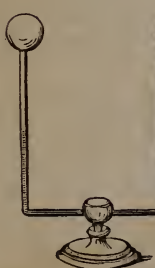
Expansion of Gases. — Gases are much more expansible than either liquids or solids; — their *rate* of expansion is uniform; and is very nearly the same for all gases, being about 480th of the whole volume for every degree of Fahrenheit.

Fig. 325.

Thermometers are instruments for measuring sensible heat by means of the expansion and contraction of some fluid. *Sanctorio's* thermometer was the first invented; —it consisted of a glass tube terminating in a bulb, partially filled with air, and the open end plunged into some coloured liquid; the expansion or contraction of the contained air was marked by the depression or rise of the liquid. This thermometer is liable to two objections: the expansibility of air is too great to mark very considerable changes of temperature; and it is liable to be influenced by atmospheric pressure.

Leslie's differential thermometer is a modification of Sanctorio's air thermometer; it consists of a glass tube bent at right angles, and terminating in two bulbs. Both bulbs contain air, but the greater part of the tube is filled with a coloured fluid. So long as the same temperature acts upon both bulbs, no change can take place; but the slightest *difference* between the temperature of the two is detected by the movement of the liquid under the pressure of the air.

Fig. 326.



Liquids are much better suited than gases for thermometers; and of liquids, mercury is the best adapted, on account of the great range between its boiling point, 656°, and its freezing point, — 40°; it is also very sensible to the action of heat; and its dilatations between 32° and 212° are nearly uniform. The essential parts of a thermometer consist of a tube of a uniform small bore, terminating in a bulb; the ball and part of the tube are filled with mercury, and the air expelled by boiling the mercury, and then hermetically sealing the tube. The *boiling point* is ascertained by immersing the bulb in boiling water; the *freezing point*, by immersing it in melting ice. The distance between these two points is marked in

various modes: in Fahrenheit's scale, the freezing point is marked 32°, and the boiling point, 212°; the intermediate divisions being 180 degrees. In the centigrade thermometer (Celsius'), the freezing point is zero, and the boiling point 100°. In Reaumur's, the freezing point is zero, and the boiling point 80°. As the ratio between these three scales is that of 180, 100, and 80, or 9, 5, 4, it is easy to reduce one to the other. The alcoholic thermometer is used when extremely low temperatures are required to be measured, alcohol having never been frozen.

The expansibility of the air by heat is the cause of the phenomena of *winds*. The sun's rays falling nearly vertically over the equator, and very obliquely at the poles, produce a very unequal temperature at these points. The air at the equator becoming rarefied, rises and creates a partial vacuum, while the cold air from the poles will rush in to supply its place. In this way two currents are established towards the equator, one from the north, and one from the south pole, besides the upward current. In consequence, however, of the earth's motion upon her axis from west to east, the two currents just alluded to will take an oblique direction from east to west. These winds are called the *trade-winds*.

COMMUNICATION, OR TRANSFER OF HEAT.

Heat may be communicated to bodies in different modes:—by *contact*, as in the conduction of solids, and the circulation of liquids; by *radiation*, and by *reflection*.

Conduction of heat.—By this is meant the passage of heat from one particle of a body to another. This conducting power is very different in different bodies. Metals are the best conductors of heat, but not all equally so; gold is the best conductor, lead the worst; glass and porcelain are worse conductors than the metals. Liquids and gases are nearly destitute of conducting power, as may be shown by applying heat to the top of them; the mode of heating them is to apply the heat at the bottom, when instantly, there are two currents set in motion, the hot particles rising towards the surface, and the colder ones descending: this process is termed *circulation* or *convection*.

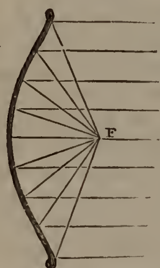
Radiation of heat.—That mode by which heat is given off to some distance on all sides, by a heated body, is termed *radiation*; and the heat, *radiant heat*. Heat is emitted from a hot body in all directions, and in straight lines or radii, just as rays of light are emitted from a luminous body. These calorific rays pass freely through the air, or a vacuum, without sensibly affecting its temperature. When they fall upon the surface of a solid body, they may be disposed of in three different ways:—1, they may be *reflected*; 2, they may be *absorbed*; or 3, they may pass through it, or be *transmitted*. In the first and third cases, the temperature of the body is unaffected; in the second case, it is elevated.

The radiating power of bodies varies very much; it depends chiefly upon the nature of their surfaces, those which are rough and soiled throwing out more heat than those which are smooth and polished; lamp-black is the best radiator, polished metals the worst. *Colour* alone has no influence upon it.

Reflection of heat resembles reflection of light. It is familiarly shown by holding a sheet of polished metal near the fire at an angle; the heat will be reflected in the corresponding angle. It may be better shown by placing a red-hot iron ball in the focus of a parabolic mirror; the calorific rays impinging on the mirror, will be reflected in straight lines; and if another similar mirror be properly adjusted, many feet distant, these rays may be made to converge again in its focus, so as to affect a thermometer placed there, or even to set fire to phosphorus.

Fig. 327.

Fig. 328.



It is a law, that the best radiators are the worst reflectors, and *vice versâ;* but the power of *absorbing* heat is in direct proportion to the radiating power. The power of absorbing heat has been shown to depend upon the *colour* of the substance, by Franklin's experiment with pieces of differently coloured cloth placed upon the surface of snow,—the darkest colour causing the most liquefaction beneath. The laws of radiation explain the formation of *dew;* the surface of the ground being cooled down after sunset by radiation, the aqueous vapour existing in the air is deposited in the form of dew. If the night be cloudy, however, the rays of heat are intercepted by the clouds which reflect them back, and hence little or no dew is deposited. It is also well known, that the most perfect radiators, such as grass, wood, leaves, &c., are the most covered with dew, while a piece of polished metal, &c., would be scarcely moistened. In the same manner also, the production of the land and sea breezes of tropical islands is accounted for.

Transmission of heat.—By this is meant the passage of the calorific rays through certain media. Substances which transmit such rays are called *transcalent*, or *diathermanous;* it may easily be shown by interposing a piece of plate glass between a red-hot body and a mirror; while all the rays of light will pass through the glass, many of the rays of heat will be arrested by it, so that but a very feeble effect is produced at the focus of the mirror. The only substance perfectly diathermanous is *rock salt;* other media, though entirely transparent, intercept the rays of heat to a greater or less extent. It has also been shown that radiant heat, like light, is capable of being *polarized.*

Vaporization.—This signifies the conversion of a solid or liquid into a vapour or gas, by heat. Vapours differ from gases only in

being easily compressed into a liquid. Vaporization includes both *ebullition* and *evaporation.* In ebullition, the formation of the vapour is so rapid, that it rises to the surface in the form of bubbles, which then burst; the point at which this takes place is called the *boiling point,* and is always constant under the same circumstances; it varies very much for different liquids: thus, for water, it is 212° F.; for alcohol, 172°; for ether, 96°; for sulphuric acid, 620°; for mercury, 662°. The boiling point is chiefly influenced by the degree of pressure to which the liquid is subjected. On the earth's surface the atmosphere exerts a pressure upon every object of 15 pounds to every square inch; this force must be overcome by the elasticity of the vapour of a liquid before it can boil; hence, as the atmospheric pressure varies, the boiling point must equally vary; hence water will boil at a much lower point on a mountain, or in a partially-exhausted receiver, than at 212°. So constant is the ratio between the depression of the boiling point and the diminution of the atmospheric pressure, that it forms a good method for ascertaining the height of mountains, —a depression of one degree being equivalent to an elevation of about 548 feet. Liquids boil, in vacuo, at a temperature of 140° lower than in the open air. The influence of diminished pressure in depressing the boiling point of a liquid, is shown in the experiment denominated the *culinary paradox.* A small flask of water is made to boil for a few minutes until the steam freely issues from the orifice; when it is firmly corked. On removing it from the heat, the ebullition of course ceases; but it may be made to commence again by simply applying cold water to the upper part of the flask; the cold condensing the vapour, and thereby diminishing the pressure.

On the other hand, the boiling point may be much elevated by increasing the pressure. In this way, water may be prevented from boiling by the pressure of its own vapour—being confined in a strong metallic vessel. There is no limit to the degree to which water may be thus heated, provided the vessel be strong enough to bear the enormous pressure of the vapour thus generated. It is on this principle that the *high pressure* steam engine acts; in it the steam is forced, both before and behind the piston, by means of sliding valves. In *low pressure* engines, a vacuum is created before and behind the piston, by means of a condenser, so that the piston is driven into a vacuum, instead of against the pressure of the atmosphere. Other circumstances modifying ebullition are *the nature of the surface of the vessel* and *the depth of the column of liquid.* The first of these depend upon the different degrees of attraction subsisting between the vessel and the liquid; the second, upon the increased pressure produced upon the lower stratum by a very tall column of liquid.

As already mentioned, a large amount of heat is rendered latent, by the production of steam.

A cubic inch of water, in becoming steam, under the ordinary pressure of the atmosphere, expands nearly into a cubic foot.

Evaporation differs from ebullition only in being a slower process, and not attended with the appearance of boiling; it occurs at common temperatures;—takes place in all fluids, and some solids, as camphor; —is much more rapid in such as have a low boiling point, as ether and alcohol. Evaporation is influenced by 1, extent of surface; 2, temperature:—heat is favourable to it; 3, hygrometric state of the atmosphere:—dryness favours it; 4, by a current of air; 5, by amount of pressure. The effect of removing the pressure is well seen by putting ether under a receiver, and removing the air; the evaporation is so rapid as to produce ebullition.

Cold is always produced by evaporation, in consequence of the amount of heat which is rendered latent. This is shown by placing a few drops of ether on the hand and exposing it to the air; or putting ether on the bulb of a thermometer, and noting the depression on the scale. By means of the cold produced by evaporation, water may be frozen by placing it over sulphuric acid in a receiver, and quickly exhausting the air. The same thing is also shown by Wollaston's *cryophorus*, or frost-carrier, which consists of a glass tube, of the figure represented in the cut. The bulb contains water, the rest

Fig. 329.

of the space being filled with aqueous vapour. The empty extremity being plunged into a mixture of snow and salt, the solidification of the vapour gives rise to such a quick evaporation from the surface of the water, that the latter freezes.

The temperature at which moisture is condensed from the air upon a cool surface, is called the *dew-point;* it varies according to the temperature and the amount of moisture present. Instruments for ascertaining the dew-point are called *hygrometers*, the simplest of which is a silver cup containing water, which is to be cooled down till moisture is deposited on the exterior, and then the temperature indicated by a thermometer placed inside.

Specific heat, or capacity for heat.—By this is meant the ratio of the heat a body may contain, with the bulk or weight of the body. A simple experiment will prove that different bodies, though exhibiting the same *apparent* temperatures, contain, in reality, very different amounts of heat. Thus, in mixing a pound of mercury at 162°, with a pound of water at 100°, the temperature of the mixture will be 102°; here, the mercury, by losing 60°, raises the water 2°. But if the water be at 162°, and the mercury at 100°, the temperature of

the mixture will be 160°; in this case, the water, by losing 2°, raises the mercury 60°. From this it appears that the same heat which would raise water 2°, will raise an equal weight of mercury 60°, being in the ratio of 1 to 30. By a similar experiment in oil and water, it is found that the ratio between them is that of 2 to 1.

There are three different modes of ascertaining the specific heat of various substances. The first is by observing the quantity of ice melted by a given weight of the substance heated to a particular temperature; the second, by noting the time which the heated body requires to cool down through a certain number of degrees; the third is the method of mixture, just pointed out, and is the one usually preferred.

The specific heat of a body is always diminished by increasing its density, and *vice versâ;* thus, a piece of iron when hammered, becomes very hot from the liberation of its heat, its *capacity for heat* being lessened. The same thing occurs when a vapour is condensed into a liquid, or a liquid into solid, and *vice versâ.*

The spheroidal condition. — By this is meant the peculiar shape which water and other liquids will assume when thrown upon a red-hot smooth metallic surface. Instead of immediately escaping as vapour, the liquid will play upon the surface in spheroidal globules until the temperature is reduced to nearly 212°, when it will suddenly explode into vapour. This is probably the cause of many steam boiler explosions; becoming red-hot, the water assumes the spheroidal state, and no steam is generated; but on suddenly cooling it down by the admission of more water, instantaneous explosion ensues.

Means of producing heat. — It will suffice here merely to mention them; viz., lenses and mirrors, percussion, friction, condensation, combination, electricity, galvanism, fermentation, and vitality.

SECTION II.

LIGHT.

There are two theories of Light: — one—the Newtonian—is that it consists of infinitely small particles, emitted by luminous bodies; the other, that of Descartes,—that it depends upon undulations transmitted through a highly elastic medium of extreme tenuity, called an *ether*, just as sound is produced by the undulations of the atmosphere.

Light travels in straight lines in every direction, with extreme rapidity; it occupies about eight minutes in coming from the sun to the earth, which is at the rate of 200,000 miles in a second.

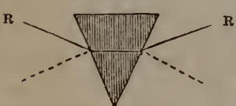
When a ray of light falls on a plane surface, it may either be absorbed, or reflected, or it may be transmitted through it.

By *reflection*, is meant that property which causes a ray of light, striking upon a bright surface, to be thrown back, at an angle which is always equal to the angle of incidence.

Refraction of light, is where a ray, in passing from one medium into another of different density, is bent from its straight line. Where the ray passes from a rarer to a denser medium, it is refracted *towards* a line perpendicular to the surface of the latter; but when it passes from a denser to a rarer medium, it is bent *from* a line perpendicular to the surface of the denser substance. Different substances possess different degrees of refractive power; generally speaking, the densest substance refracts most; the same is true also of combustible substances.

White light is compound,—that is, it is made up of different coloured rays, as may be proved by admitting a ray of light through a small aperture into a dark room, and interposing a glass prism; it will not only be refracted from its straight course, but will be decomposed into seven differently-coloured spaces, forming a figure termed the *solar spectrum*. The upper part of the spectrum is red; the lower, violet; the intermediate portion, commencing with the violet, being indigo, blue, green, yellow, and orange, all gradually shading off into each other. These were termed by Newton the *prismatic* or *primary* colours, from the impression that they were the elements of white light.

Fig. 330.



Brewster's opinion, which is rather the received one at present, is, that there are only *three* primary colours, viz., *blue, yellow*, and *red;* and that when these are mixed in definite proportions, white light will result; but that when any of them is in excess, then the effect of *colour* will be produced. The colours of natural objects are supposed to result from the surfaces of these bodies absorbing certain rays, and reflecting or transmitting others; thus an object appears *red*, because it absorbs a portion of the yellow and the blue rays composing the white light which falls upon it, while it reflects the red rays; it appears *white* when it reflects all the rays, and *black* when it absorbs them all.

The greatest *illuminating* power of the spectrum is about its middle, or rather, between the yellow and green; the greatest *heating* power is in the red space or beyond it, varying with the kind of prism used; the *deoxidizing* power is greatest in the violet space, or just beyond it. The red ray is the least refrangible; the violet ray the most so.

The *chemical* effects of light are well marked; thus a mixture of chlorine and hydrogen may be kept for any length of time in the dark; but under the influence of light, a combination soon ensues; so the blackening and the decomposition of the salts of silver occur rapidly

in the light. But the most remarkable chemical effect produced by light is upon the leaves of growing plants, which then possess the property of decomposing the carbonic acid of the air, appropriating the carbon to themselves, and giving out the oxygen.

Rays of light are *absorbed* much more by some bodies than by others. As a general rule those which absorb radiant heat most, are the best absorbers of light. Colour appears to exercise a great degree of influence over it; dark-coloured substances, for this reason, become sooner heated than light-coloured ones.

A ray of light when made to pass through certain kinds of crystals, as Iceland spar, is divided into two, one of which is refracted in the ordinary way, the other taking an extraordinary direction; this is denominated *double refraction.*

Another property of light is its capability of *polarization.*

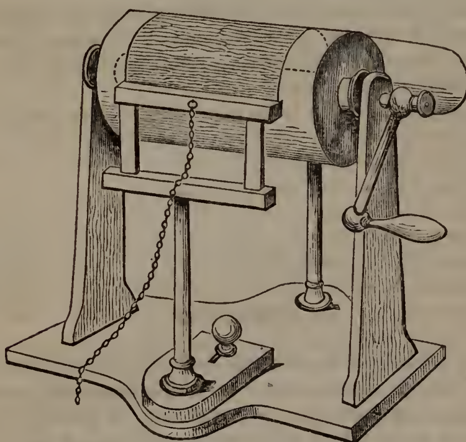
SECTION III.

ELECTRICITY.

THE term *electricity* is derived from the Greek word signifying *amber*, since this is the substance in which electrical excitement was first discovered. Electrical excitement may be produced by rubbing glass, amber, or resin, which will then attract light bodies. There are two varieties or states of electricity, the *vitreous*, or that excited in glass, which is also called *positive* electricity, and the *resinous*, or that excited in resins, called also *negative* electricity. The difference between these may be easily shown by suspending a light pith-ball, or a feather, by means of a thread of silk; then on exciting a dry glass tube and presenting it to it, the body will be attracted, but after a few moments it will be repelled, in consequence of receiving electricity from the glass tube; if now, a stick of resin properly excited be presented to it, it will be attracted; but after touching the resin and receiving some of its electricity, it will soon be repelled by it; but on the other hand, attracted by the glass. This experiment establishes the law "that bodies similarly electrified, repel each other, but dissimilarly electrified they attract." Electricians divide bodies into *electrics*, or *non-conductors*, as glass, resin, sulphur, &c., and *non-electrics* or *conductors*, as the metals, water, &c. The essential parts of the *electrical machine*, are, 1, the *electric*, which is usually a glass cylinder or plate, contrived so as to be capable of turning by means of a handle; 2, the *rubber*, which is a stuffed cushion covered with an amalgam of tin, zinc, and mercury, against which the electric is rubbed; 3, the *prime conductor*, which is a metallic cylinder armed with a number of points

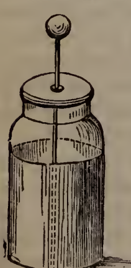
for the more perfect collection of the electricity. Both cushion and conductor should be *insulated*, that is, supported on a pedestal of glass, which is a non-conductor. The cylinder, as it turns, becomes charged with positive (vitreous) electricity, by friction against the cushion, and is as quickly discharged, by the rows of points, into the prime conductor, which, as it is insulated, thus acquires a charge of positive elec-

Fig. 331.



tricity, which it will yield up on contact with any body, with a peculiar noise and spark. The maximum effect is produced when the rubber is made to communicate with the earth by means of a chain. If *negative* electricity be wanted, the conductor must be made to communicate with the earth, and the rubber insulated, the electricity being drawn from the latter.

Fig. 332.



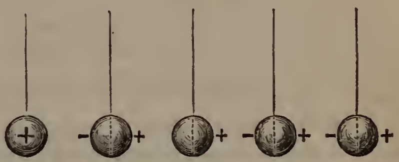
The *Leyden jar* is an instrument for *accumulating* electricity. It depends on the principle that a large amount of the two different sorts of electricity may reside on the two surfaces without any tendency to equilibrium, on account of the non-conducting power of the glass. It consists of a thin glass jar coated on both sides with tin foil to within a few inches of the top; a wire, terminating in a metallic knob, communicates with the interior coating. When the outside coating is connected with the earth, and the knob placed near the prime conductor of the machine, the inner and outer surfaces become respectively positive and negative. If, now, the two coatings be made to connect by means

of a bent wire, the equilibrium is restored, a bright spark is perceived, along with a sharp snap, and if the body be interposed, the *electric shock* is felt.

The *electric battery* is only a great number of such jars connected together by their inner and outer coatings respectively; the whole then act as one very large jar, by which great extent of surface and an enormous accumulation of electricity are gained; the whole may be discharged at the same moment, and the effect is, of course, exceedingly powerful.

By *electrical induction* is meant the power which an electrified body has to produce an opposite electric condition in a contiguous body; it is by virtue of this law, that when an electrified body, as a glass tube previously rubbed, approaches a light body, as a feather or pith-ball, it immediately *attracts* it, having first *induced* in it an opposite electrical state. A series of globes suspended by silk threads, in the manner represented, will each become electric by *induction*, when a charged body is brought near the end of the series. The positive and negative signs are intended to represent the *states*.

Fig. 333.



The electrical state of the atmosphere is liable to disturbance: experiment has shown that the higher regions of the air are usually in a positive state: in cloudy and stormy weather, the clouds near the surface often appear in a negative state. In a thunder-storm, the cloud and the earth may be considered as representing the two coatings of the Leyden jar, differently electrified, — and the intervening air, the bad conducting glass. The dangerous effects of lightning are much lessened by the use of *lightning rods*, which are metallic conductors terminating above in a point, and below passing to a considerable depth into the earth. The object of the *pointed* extremity is to conduct off the discharge silently; a blunt extremity would give rise to a spark, and perhaps a shock, which might be unsafe; this may be easily shown by experiment with the electrical machine.

Fig. 334.

Electrometers and *electroscopes* are instruments for indicating or measuring the electrical intensity. The most simple one is that named the *gold leaf electrometer;* it consists of a pair of gold leaves suspended from the top of a bell-jar and communicating above with a metallic cap. When an electrified body is brought near the cap, its presence is immediately detected by the divergence of the gold leaves. There are other electrometers known by the

names of *quadrant electrometer, torsion electrometer, balance electrometer*, &c.

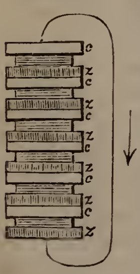
Two theories of electricity have long been maintained. One is the *theory of two fluids*, which supposes two distinct kinds of electricity, and that these exist in all substances, the one named *vitreous*, because developed in glass, the other *resinous*, because manifested in resins; that these two fluids neutralized each other, and preserved an equilibrium in bodies at rest; but that when this equilibrium was disturbed by friction, &c., one or other kind of electricity was displayed. The other is the *theory of a single fluid*, or that of Franklin. It supposes all bodies to possess it in a certain amount, and that their equilibrium is constantly liable to disturbance by friction, &c.; that when it is in excess, it is *positively* excited; when in deficiency, it is *negatively* excited; and that there is a constant tendency to an equilibrium.

SECTION IV.

GALVANISM, OR VOLTAIC ELECTRICITY.

When two solid bodies, as two pieces of metal, are plunged into a liquid capable of acting upon them unequally, the electric equilibrium is disturbed, the one acquiring the positive condition, and the other the negative. Thus, a piece of zinc and a piece of copper, placed in a dilute solution of sulphuric acid, will cause such a disturbance of the electrical equilibrium; the zinc being the metal most attacked, becomes *positive*, while the copper becomes *negative;* and in making a communication between the two, an electrical current is set in motion. The intensity of the electricity thus developed is extremely feeble; but by arranging a number of single pairs of metals with the intervention of a fluid, or moistened cloth, in such a manner that the direction of the current shall be the same in each, the intensity will be very much augmented; upon this principle the *Pile of Volta* and the *Crown of Cups* are contrived.

Fig. 335.

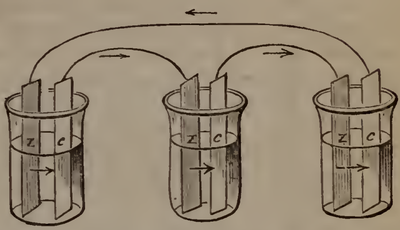


The *Voltaic pile* consists of a number of small plates of zinc and copper arranged in a pile, each pair being separated by means of a piece of cloth moistened with sulphuric acid, as seen by the figure. If the two terminal plates be now touched with wet hands, a prolonged electric shock will be experienced, the intensity of which may be increased to almost any extent, by simply increasing the number of plates.

The *Crown of Cups* is similar in principle, though different in form; it consists of any number of cups or glasses, arranged in a row or circle, each containing a piece of copper and zinc, and some dilute acid

The copper of the first cup is connected with the zinc of the second; the copper of the second, with the zinc of the third, and so on; on establishing a communication between the first and last plates, a discharge takes place as before.

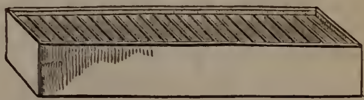
Fig. 336.



Whenever such an arrangement consists merely of a single pair of conductors, and an interposed liquid, it is called a *simple circuit;* when two or more alternations are concerned, it is a *compound circuit;* but however complex the apparatus may be, the principle is, in all cases, precisely the same. The disturbance of the equilibrium may be considered as commencing at the surface of the most oxidizable metal, and to be propagated through the liquid to the least oxidizable metal; hence, when insulated, the zinc end of the series is always negative, and the copper end positive. When the two extremities are joined, the current continues to pass from the copper to the zinc; so that in fact, we may consider that there are two currents: one *in* the battery, passing from the zinc to the copper; the other *out* of the battery, going from the copper to the zinc, as shown by the arrows in the preceding figure.

Cruikshank's trough is a modification of Volta's pile; it consists of numerous pairs of zinc and copper plates soldered together, and cemented water-tight into a mahogany trough, which thus becomes divided into a series of cells or compartments, capable of receiviug the exciting liquid. This apparatus is well adapted to exhibit effects of tension, and give shocks.

Fig. 337.



The *quantity* of electricity set free, is to be distinguished from its *tension;* the first is measured by its *chemical* effects—particularly the power of decomposition, and depends on the surface; the last, by its power of overcoming obstacles, and passing through imperfect conductors; it depends on the number of plates. The energy of a Voltaic current is measured by the deflection of a magnetic needle.

Different theories as to the nature and cause of galvanism. — Galvani supposed it to be developed in the animal upon which he was experimenting, and that the metals served merely as conductors; Volta, on the other hand, supposed it to be developed by the contact of dissimilar metals. Subsequently, Faraday brought forward the theory of *chemical action*, which is now most generally adopted.

The most important effect produced by galvanism, is that of the decomposition of compound bodies. It was by means of this agent that Sir H. Davy made the discovery of the metals of the alkalies. When compound bodies in the fluid state are traversed by a galvanic circuit, a decomposition usually takes place according to a uniform and constant rule; certain elements, as oxygen, chlorine, iodine, acids, &c., appearing at the positive or *zinc* end of the battery, and others, as hydrogen, the metals, &c., at the *copper* or negative end. Hence the division of bodies by chemists according to their electrical habitudes; those which go to the positive pole being called *electro-negative*, — at the head of which stands oxygen; and those which go to the negative pole being called *electro-positive*, of which hydrogen is the first.

The *electrodes* or *poles* of a battery are the points of the circuit (usually the extremities) where the electrical phenomena are manifested. The decomposition of a fluid by galvanic action is termed *electrolysis;* and the liquids which are capable of being thus acted on are named *electrolytes.*

A *constant* battery is one which preserves its power of action for an indefinite time. The common zinc and copper battery soon loses its power, from the fact that the sulphate of zinc gradually formed is also gradually decomposed by the hydrogen constantly evolved at the copper plate, on which the reduced metallic zinc becomes deposited, converting, as it were, the copper into a zinc plate. Various constant batteries are in use, as Daniel's, Children's, Grove's, &c.

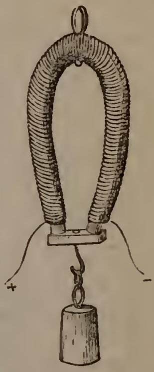
Magnetic effects of galvanism. — Among the effects of galvanism, its influence over the magnet is very remarkable. Although the fact had been long known that electricity was capable of inducing and destroying magnetism, as witnessed in the effects of lightning on the compass-needle, it was not until the year 1819 that the laws of these phenomena were established by Œrsted, and the science of *electro-magnetism* truly developed. It is found that if a galvanic current be set in motion near a magnetic needle, the latter will arrange itself across the current, so that its axis may be perpendicular to the wire.

To ascertain the direction of a current, or the deflection of a needle, the following simple plan will assist: let a person suppose his own body to be the conducting wire, and to be placed in its position; then, while looking at the marked pole, and the current is passing from his head to his feet, it will be deflected to the right hand; if from his feet to his head, to the left hand.

When an electric current is passed at right angles to a piece of iron or steel, the latter acquires magnetic polarity, either temporary or permanent; the direction of the current determining the position of the poles. This effect is very much increased by causing the current to circulate a number of times around the bar, which soon acquires extraordinary magnetic power. A piece of soft iron in the form of a horseshoe, surrounded thus by a coil of copper wire, insulated by being covered with silk, may be made to become so highly magnetic, simply

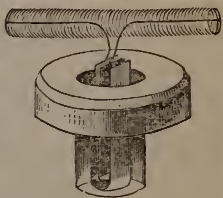
by connecting the two ends of the iron with a small battery of a single pair of plates, as to be capable of sustaining a very heavy weight.

Fig. 338.



As electricity can produce a magnetic influence, in the same manner it is found that magnetism can call into activity electric currents. If the two extremities of the coil of the electro-magnet just described, be connected with a galvanoscope, and the iron magnetized by the application of a steel horseshoe magnet to the ends of the bar, a momentary current will be developed in the wire, and pointed out by the movement of the needle. On removing the magnet, whereby the polarity of the iron is at once destroyed, a second current will become apparent, but in the opposite direction to that of the first. By using a very powerful steel magnet, surrounding its iron keeper or armature with a very long coil of wire, and then making the armature itself rotate in front of the faces of the magnet, so that its induced polarity shall be rapidly reversed, magneto-electric currents may be produced of such intensity as to give bright sparks, and powerful shocks, and exhibit all the phenomena of voltaic electricity. The accompanying figure represents such an arrangement.—There is a great variety of form in electro-magnetic machinery; but in all, even the most complicated, the *essential principle* is the same, viz.: the development of an electrical current by magnetic action.

Fig. 339.



The earth is supposed to be a great magnet, having electric circles traversing it at right angles from east to west, and having its north and south pole corresponding to its respective geographical poles; hence the north pole of a magnet should really be considered its south pole, and *vice versâ*, because opposite poles attract. For this reason the poles of a magnet are now often named the *marked* and *unmarked* poles.

It has lately been announced by Faraday, that oxygen gas is highly magnetic.

PART II.

INORGANIC CHEMISTRY.

CHAPTER I.

PRELIMINARY REMARKS ON CHEMICAL NOMENCLATURE, AFFINITY, ETC.

Material substances are divided by the chemist into *simple* or *elementary*, and *compound*. The simple bodies are such as have as yet resisted all efforts to decompose them. Compound bodies are those that may be resolved into two or more elements. It is possible that some bodies at present regarded as elementary may hereafter prove to be compound, as was the case with the alkalies.

The number of simple bodies recognised by chemists at the present day is sixty-five; of these, fifty-two belong to the class of metals, and thirteen to the class of non-metallic bodies.

CHEMICAL NOMENCLATURE.

In the formation of a chemical nomenclature, the names given to many of the elements were expressive of some of their striking properties:—thus *oxygen*, from two Greek words, signifying to produce an acid, from the idea that oxygen was the sole acidifying principle; *hydrogen*, from two words signifying to produce water;—others again derived their names from words expressive of their *colour*, as chlorine, iodine, cyanogen, &c. The compounds of oxygen were named *oxides* or *acids*, according as they do, or do not possess acidity. Acids derive their name from the substance acidified by the oxygen, by the termination in *ic;* thus sulphur*ic*, carbon*ic*, phosphor*ic*, &c. Should the substance be capable of forming more than one acid, the name of that containing least oxygen is made to terminate in *ous,* as sulphur*ous*, nitr*ous*, &c. When the same substance forms several acids with oxygen, the Greek preposition *hypo* is generally prefixed to express the relative quantity of oxygen; thus *hypo*nitrous and *hypo*sulphuric indicate acids containing less oxygen than nitrous and sulphuric acids respectively; sometimes the particle *per* is prefixed to express the highest amount of oxygen, as *per*chloric acid.

The nomenclature of the *salts* is made to depend on the termination of their acid; thus, acids ending in *ous* form salts terminating in *ite*, as sulph*ite*, nitr*ite*, from sulphur*ous* and nitr*ous* acids; acids ending in *ic*, as sulphur*ic* or nitr*ic*, form salts terminating in *ate*, as sulph*ate* and nitr*ate*.

The termination of names of compound bodies is directed chiefly by analogy; thus the non-acid compounds of chlorine, iodine, bro-

mine and fluorine, from the analogy of these bodies with oxygen, are named chlor*ides*, brom*ides*, iod*ides*, &c. The compounds of the inflammables terminate generally in *uret*, as carb*uret*, sulph*uret*, phosph*uret*, &c.

Different *oxides* of the same metal are distinguished by the numerals prefixed. The oxide containing a single equivalent of the metal and oxygen is named *pro*toxide; that containing the greatest amount of oxygen, the *per*oxide; the intermediate oxides are expressed by Latin numerals, as the *deut*oxide or *bin*oxide, *ter*oxide or *trit*oxide, &c.; the Greek numerals, *dis*, *tris*, &c., prefixed, denote oxides containing one equivalent of oxygen with *two*, *three*, or *more* equivalents of the metal; thus, the *di*oxide of copper. A *sub*oxide signifies an oxide containing less oxygen than a protoxide.

The same system is also extended to salts, where there is more than one formed by an acid with the same base. When the salt is *neutral* it is simply named according to the nature of the acid, as sulphate, or nitrate; if it contains two equivalents of the acid, it is named a *bi*sulphate, or a *bi*carbonate, &c. If it contains two equivalents of the base, it is named a *di*sulphate, &c. The term *sesqui*, (one and a half), is used to indicate the relation of 1 to $1\frac{1}{2}$, or 2 to 3, as in the sesquioxide of iron, a compound consisting of two eq. of iron and three of oxygen.

The generic part of the name of a compound is usually formed from that ingredient which is the most electro-negative; thus, in compounds formed between oxygen, chlorine, iodine and sulphur, we say oxide of chlorine, chloride of iodine, iodide of sulphur; and not chloride of oxygen, iodide of chlorine, or sulphuret of iodine.

It is often, however, very difficult to apply appropriate names to the highly-complex bodies of the organic world; in which cases more particularly, the use of chemical signs or *symbols* becomes very advantageous, as will be briefly shown.

Every elementary substance is designated by the first letter of its Latin name, in capital, or by the first letter conjoined with a second small one most characteristic, since the names of many bodies begin alike; thus, Aluminium, Al.; Arsenic, As.; Bromine, Br.; Boron, B.; Barium, Ba.; Carbon, C.; Chlorine, Cl.; Hydrogen, H.; Iodine, I.; Iron (ferrum), Fe.; &c. It is always understood that these symbols express *one equivalent of the substance.*

Combination between bodies is expressed by a mere juxtaposition of the symbols, or sometimes by interposing the sign +: thus water is expressed by HO, or H+O; hydrochloric acid, by H Cl, or H+Cl; protoxide of iron, by FeO, or Fe+O.

When more than one equivalent is intended, the number is either prefixed to the symbol, or else placed after it: thus, sulphuric acid, S+3O, or SO^3, or SO_3; hyposulphuric acid, 2S+5O, or S^2O^5, or S_2O_5, &c. Sometimes abbreviations are made use of: thus, two equivalents of a substance are indicated by the symbol with a short

line drawn through or below it; an equivalent of oxygen is signified by a dot, and one of sulphur by a comma, thus sesquioxide of iron, $\overset{\cdots}{\text{F}}\text{e}$.; bisulphuret of carbon,$\overset{,,}{\text{C}}$, instead of CS_2.

A number placed before a compound multiplies all that follows in that compound; thus, the formula expressing three equivalents of the sulphate of the sesquioxide of iron is written $3\ (Fe_2O_3+3SO_3)$

CHEMICAL AFFINITY.

This is the attraction existing between the heterogeneous elements of compound bodies, whilst *cohesion* is the attraction between homogeneous particles. In water and sulphuric acid, for instance, both compound bodies, the chemical affinity is exerted between the oxygen and hydrogen in the one case, and between the sulphur and oxygen in the other. The most simple case of chemical affinity is where two bodies unite together to form a third body; as copper and zinc forming brass; sulphuric acid and soda to form sulphate of soda.

The second case of affinity, called *single elective attraction*, is where two heterogeneous bodies having united together to form a compound, another body, being blended with them in solution, unites with one of the former; for example, potash being added to a solution of sulphate of magnesia, unites with the sulphuric acid, and precipitates the magnesia; water on being added to the tincture of camphor (camphor and alcohol), will unite with the alcohol and precipitate the camphor

The third case of affinity, called *double elective attraction*, is where two compound bodies, on being intimately mingled, undergo a mutual decomposition, the four components interchanging places: thus, a solution of acetate of lead and a solution of sulphate of zinc, on being mixed, give rise to an acetate of zinc and a sulphate of lead.

The *fourth* case of affinity is where two bodies being in combination, a third, on being added in excess, combines with both the others; thus, ammonia being added to the solution of sulphate of copper, at first throws down the oxide of copper; but on continuing to add the ammonia, the excess combines with the precipitated oxide, which is then redissolved.

Circumstances modifying chemical affinity.—One of these is *heat;* thus, by heating mercury in the air, it will combine with oxygen; and by simply increasing the temperature, it will separate again from the oxygen. Another modifying agent is *solution:* many substances which, when in the dry state, evince no tendency to unite, when moistened or dissolved, exhibit a powerful affinity; thus tartaric acid and a carbonated alkali may be kept together, if dry, without any union; but if moistened, effervescence takes place. *Mechanical division* also greatly promotes chemical action, by overcoming cohesion, as may be seen by the action of nitric acid on a brass ball being far less violent than when the metal is presented to it in the form of filings or

leaves. The *nascent state* is also peculiarly favourable to chemical combination.

Tables of affinity consist of a series of substances placed in a column, in the order of their affinity for any one substance at the head of the column, as in the following example:

Sulphuric Acid.

Baryta,
Strontia,
Potash,
Lime,
Magnesia,
Ammonia.

The Atomic Theory.—The doctrine of *atomic weights* and *chemical equivalents* is based upon the supposition that every substance is divisible into ultimate particles termed *atoms*, which atoms unite together in certain definite proportions to form various compound bodies.

The *Chemical Equivalent* of a body is the number expressing its *least combining proportional;* as these merely express the ratio, any one body may be selected as a standard; either oxygen or hydrogen are generally employed,—more frequently hydrogen,—which being placed at unity, the *equivalent number* or *chemical equivalent* of oxygen would be 8; since eight atoms of oxygen always unite with one of hydrogen. In the same way the equivalent of chlorine has been fixed at 36; that of nitrogen at 14; that of iron at 28; and so on. An atom of a compound body will of course be compound, as an atom of water, or of sulphuric acid; so also, the *chemical equivalent* of a compound body is the sum of the equivalents of its constituents; thus the equivalent of water is 9 $(8+1)$; that of sulphuric acid 40 $(16+24)$; and so on.

LAWS OF CHEMICAL COMBINATION.

1. All chemical compounds are fixed and definite in their nature, the ratio of the elements being constant. This is termed the *law of definite proportions.*

2. *The law of multiple proportions.*—When any body is capable of uniting with a second in several proportions, these proportions bear a simple relation to each other. This is well illustrated in the series of compounds of nitrogen and oxygen, in which, while the nitrogen remains the same, the quantities of oxygen increase by multiples of 8; thus 8, 8×2, 8×3, 8×4, 8×5 give respectively the quantities of oxygen contained in the protoxide of nitrogen, the deutoxide, hyponitrous acid, nitrous acid, and nitric acid.

3. *The law of equivalents.*—The proportions in which several bodies unite with any given body represent the relations in which they unite among themselves. Take oxygen as an example: the proportions in which sulphur, chlorine, carbon, and iron unite with oxygen, are re-

spectively 16, 36, 6, and 27, for every 8 parts of oxygen. Now, according to the above law, these bodies will combine with each other in the same proportion,—thus carbon and oxygen in the ratio of 6 to 8, &c. These proportions are named *equivalents* or *combining* numbers. The law holds equally true for compound bodies.

It is obvious that any body may be assumed as unity; generally hydrogen is so assumed, in which case the equivalent of oxygen is 8.

SECTION I.

SIMPLE NON-METALLIC BODIES.

OXYGEN

Exists abundantly in nature, constituting one-fifth of the atmosphere, and eight parts in nine of water; also, in all organic matter.

Discovered in 1771 by Priestley, and by Scheele in 1775; named *dephlogisticated air* by Priestley, *empyreal air* by Scheele, and *vital air* by Condorcet;—the name *oxygen*, derived from two Greek words signifying to *generate an acid*, was given by Lavoisier, under the idea that it was the sole acidifying principle.—*Prepared* by heating either the peroxides of mercury, lead, or manganese, or the nitrate or chlorate of potassa. When either of the peroxides is exposed to heat, a portion of their oxygen is driven off, and they are converted into either protoxides or sesquioxides. Perhaps the best mode of procuring it is to heat the chlorate of potassa, which yields a large quantity of oxygen,—the gas coming both from the acid and base, and the salt becoming converted into the chloride of potassium. This is shown by the following diagram:

Chlorate of Potassa {
- Chloric Acid { Chlorine → Chloride of Potassium.
- Chloric Acid { 5 Oxygen → 6 eq. oxygen.
- Potassa { Potassium → Chloride of Potassium.
- Potassa { Oxygen → 6 eq. oxygen.

If a little powdered peroxide of manganese be previously mixed with the chlorate of potassa, a less amount of heat will be required, although none of the oxygen comes from the manganese. Oxygen should be collected over water, in a *pneumatic trough*,—a large vessel containing water, and fitted with a shelf for holding the receivers, which must always be below the level of the liquid.

Properties.—Colourless, tasteless, inodorous; sp. gr. 1·1026;—has never been condensed into a liquid; it is the most perfect negative electric; is very sparingly soluble in water; a powerful supporter of combustion and of life; has a strong attraction for most simple bodies. Its power of supporting combustion is shown by immersing

in it a candle with a red-hot wick, which is instantly relighted; or by the burning of fine iron wire, or of phosphorus and sulphur, in it; the compounds which are always thus formed are termed either *acids* or *oxides*, according as they do, or do not, possess acid properties. *Ordinary combustion* is only the rapid union of a body with oxygen; and the body, when burnt, is always increased in weight; which increase is exactly equal to the amount of oxygen which has disappeared. Oxygen is equally essential to respiration; no animal can live in an atmosphere deprived of oxygen; pure oxygen is injurious to life, on account of its highly-stimulating properties, all of the functions becoming extremely excited. Eq.=8; — combining volume=50; — Symbol, O.

Theory of combustion. — The term *combustion*, in its widest sense, signifies "a chemical combination, attended with the evolution of light and heat." In its *restricted* sense, it means "the rapid union of a combustible with oxygen." Before the discovery of oxygen gas, the phenomena of combustion were explained on the *Stahlian*, or *phlogistic theory*, that all combustibles contained a principle named *phlogiston*, to which they owed their combustibility; and that when they burned, they gave out their phlogiston, and then ceased to be combustible. A metallic oxide was consequently regarded as a simple substance, and the metal itself as a compound of the oxide with phlogiston.

Lavoisier proved the incorrectness of this doctrine, by showing that a body on undergoing combustion, so far from giving out anything, always acquires oxygen; thus, on burning a piece of phosphorus in oxygen, some of the gas disappeared, the phosphorus increased in weight, and the increase of the latter was precisely equal to the loss of the former. Lavoisier, however, went too far in supposing that oxygen was the *sole* supporter of combustion; since it has been proved that other gases, as chlorine, cyanogen, &c., will also support it. He also accounted for the intense light and heat produced during combustion, on the principle of latent heat; but in this he was subsequently proved to be incorrect. No certain explanation of these phenomena have indeed been given, though they have been attributed to *chemical action* by some, and to *electricity* by others; this latter view is adopted by Berzelius.

All combustibles do not emit an equal amount of heat on being burned.

HYDROGEN

Exists abundantly in nature; constitutes one-ninth by weight, of water, and two-thirds by volume; named from the Greek words signifying *to generate water*. *Prepared*, always by decomposing water, which may be effected either by bringing steam in contact with red-hot iron, which then combines with the oxygen of the water, liberating pure hydrogen; or by the action of dilute sulphuric acid on

pieces of zinc or iron; in this case the water of the sulphuric acid yields its oxygen to the zinc, and its hydrogen escapes: the oxide of zinc at the same time unites with the acid to form the *sulphate of zinc*, thus:—

Water { Hydrogen ———————————— Free.
Water { Oxygen ———————————— oxide of zinc.
Zinc ———————————— oxide of zinc.
Sulphuric acid ———————————— } Sulphate of oxide of zinc.

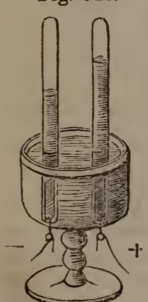
Prop.—Colourless, inodorous, tasteless; the lightest body in nature, sp. gr. 0·06896; 100 cubic inches only weigh 2·137 grs. It cannot be compressed into a liquid; a non-supporter of combustion and respiration, though this latter property arises, not from any noxious property of the gas, but only from an absence of oxygen; it is highly inflammable, burning with a pale bluish flame; when mixed with a due proportion of oxygen (2 measures of hydrogen to 1 of oxygen), it explodes violently, either by a heated body, or the electric spark, giving rise to the formation of water.

Spongy platinum is instantly made red hot by a jet of hydrogen, which, in its turn, is then inflamed;—a mixture of hydrogen and oxygen, will burn slowly without explosion, when the temperature is raised a little above that of boiling mercury. The burning of hydrogen with oxygen is accompanied with the evolution of a great amount of heat; on this principle the *oxy-hydrogen blowpipe* is constructed, consisting of an apparatus by which a mixture of hydrogen and oxygen is made to burn from a jet, care being taken to guard against the danger of explosion, by means of Hemming's safety tube; the heat thus produced is sufficient to melt the most refractory metals. A burning jet of this when thrown upon a piece of lime constitutes the *Drummond light.*—Symb. H;—Eq. 1.

Hydrogen forms two compounds with oxygen: water, or the *protoxide*, and the *peroxide*.

Water, HO.—First proved to be composed of hydrogen and oxygen, by Cavendish; this may be shown *synthetically*, by mixing one volume of oxygen with two of hydrogen, and exploding the mixture, when water will be the sole product,—or, *analytically*, by decomposing water either by a red-hot iron, or by galvanism; in the last case, a small portion of water is interposed between a pair of platinum plates connected with the extremities of a voltaic apparatus of moderate power; pure oxygen gas is evolved at the positive plate (or that connected at the copper end), and pure hydrogen at the negative, or zinc extremity; the gases may be properly collected and measured.

Fig. 340.



The composition of water is, by weight, 8 parts of oxygen, and 1 of hydrogen; by volume, 1 volume of oxygen, and 2 of hydrogen.

Prop. — Colourless, inodorous, tasteless; a powerful refractor of light; an imperfect conductor of heat and electricity; very incompressible; sp. gr. 1. It does not occur, in nature, chemically pure; can only be procured pure by distillation. Freezing point, 32° F.; boiling point, 212° F.; greatest density, at 40° F. Water acts powerfully as a chemical agent, both as an acid and as a base; in the first case, forming compounds termed *hydrates*, when sometimes the reaction is accompanied with the evolution of heat, as in the slaking of lime; in the second case, uniting with the so-called acids; dry sulphuric acid can evince no acid properties, unless water be present to act as a base, but this base may be substituted by a more powerful one, as the oxide of iron, or of zinc. Water also enters into the composition of many crystals, constituting their *water of crystallization*, or water necessary to the crystalline form, and *constitutional water*, or water essential to the existence of the salt. Its *solvent* properties are pre-eminent. Water in its natural state always contains atmospheric air, as may be shown by placing it under a receiver and exhausting the air; bubbles of gas will make their escape. Recently-boiled water has the property of absorbing gases, though in different degrees.

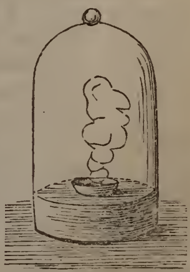
Peroxide of Hydrogen, HO_2, called also *oxygenated water*, is procured from the peroxide of barium, by the action of dilute hydrochloric acid, and then precipitating the baryta by sulphuric acid; the excess of oxygen of the peroxide, instead of escaping, unites with the water, converting it into the peroxide of hydrogen.

Prop.—A colourless, transparent liquid; inodorous; has a metallic taste; sp. gr. 1·45; remarkable for its proneness to decomposition,—a temperature of 212° causing explosion; it also bleaches and oxidizes.

NITROGEN

Constitutes about four-fifths of the atmosphere, and is found abundantly in nature, under various combinations. It may be procured in several ways, of which the most simple is to burn out the oxygen from a confined portion of air, in a bell-glass inverted over a dish of water, by means of a piece of phosphorus; the phosphorus is converted into phosphoric acid, and the remaining gas is tolerably pure nitrogen. A purer gas may be obtained by passing atmospheric air over copper heated to redness; or by passing chlorine through a solution of ammonia (nitrogen and hydrogen);—in this last case there is a risk of the formation of the chloride of nitrogen, a very explosive compound.

Fig. 341.



Prop. — Distinguished for its negative properties; destitute of colour, taste, and smell; a non-supporter of combustion and life; has no noxious properties; is not inflammable; sp. gr. ·972; Eq. = 14·15; Symb. N.

Nitrogen forms five compounds with oxygen, and one mixture, viz.: the atmosphere.

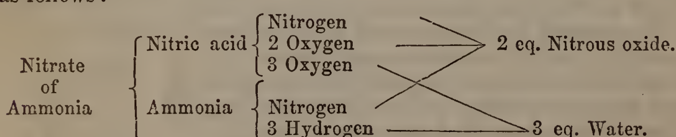
The *atmosphere* is composed of about four-fifths of nitrogen, one-fifth of oxygen, and some carbonic acid and watery vapour. The air may be analyzed either by burning a piece of phosphorus in a known portion of it, or by passing it over a finely-divided copper, heated to redness, or by mixing it with hydrogen in definite proportions, and exploding the mixture by the electric spark; the last method is best accomplished by means of a *eudiometer*—a stout glass tube, so arranged that known bulks of gas can be measured. Suppose, 100 measures of atmospheric air be mixed with 50 of hydrogen, and the mixture exploded; the volume, after explosion, will be found reduced to 87 measures; hence there has been a diminution of 63 measures, of which one-third, or 21 measures, is oxygen; the remaining two-thirds is hydrogen.

Prop.—Colourless and invisible; when pure, has no taste or smell; sp. gr. 1; it is 800 times lighter than water at 60°. At the level of the sea, it exerts a pressuse of 15 pounds on every square inch, and is capable of supporting a column of water 34 feet high, and one of mercury 30 inches; that is, a column of mercury one inch square and 30 inches long, has the same weight (nearly 15 pounds) as a column of water 34 feet long, and as a column of air of equal base reaching to the extreme limit of the atmosphere.

COMPOUNDS OF NITROGEN WITH OXYGEN.

These are Protoxide of Nitrogen, Deutoxide of Nitrogen, Nitrous Acid, Peroxide of Nitrogen, and Nitric Acid.

Protoxide of nitrogen, NO, called also *nitrous oxide* and *laughing gas;*—prepared by heating the nitrate of ammonia. The rationale is as follows:



Prop.—Colourless, transparent, almost inodorous; sp. gr. 1·5; a powerful supporter of combustion; water dissolves nearly its own volume; may be condensed into a liquid at 45° by a pressure of 50 atmospheres; when mixed with hydrogen in equal volumes, it explodes with violence by the electric spark, liberating its own measure of nitrogen. Its most remarkable property is its exhilirating effect on the animal system, when respired.

Deutoxide, or *Binoxide of nitrogen*, NO_2;—prepared by the action of nitric acid on copper turnings; part of the oxygen of the acid combines with the copper, the oxide thus formed uniting with the undecomposed nitric acid; another portion of the oxygen unites with the

nitrogen to form the deutoxide. It is colourless, but has a strong affinity for oxygen; it acquires a dark red colour when it comes in contact with the air, which will serve to distinguish it; it is irrespirable; a supporter of combustion in some cases,—as of charcoal and phosphorus; but it extinguishes a lighted candle. From its affinity for oxygen, it may be used with advantage in *eudiometry*.

Nitrous acid, NO_3; prepared by adding four measures of deutoxide of nitrogen to one of oxygen, and exposing the mixture to a temperature of 0° F.; they condense into a thin liquid of a greenish colour;—vapour, orange red; it is decomposed by water into nitric acid and deutoxide of nitrogen; it cannot be made to unite *directly* with metallic oxides.

Peroxide of nitrogen, NO_4, is always formed whenever deutoxide of nitrogen comes in contact with the atmospheric air, producing dense orange-coloured fumes;—procured in a liquid form by heating nitrate of lead in a retort; oxide of lead remains behind, and the acid is resolved into a mixture of oxygen and nitrous acid, the latter being condensed into a liquid by surrounding the receiver by a powerful freezing mixture.

Prop.—At a low temperature it is nearly colourless; acquires an orange tint on raising the temperature; sp. gr. 1·451; very volatile, boiling at 82°;—is acid, pungent, and corrosive; is decomposed, on being added to water, into nitric acid and deutoxide of nitrogen; very irrespirable; supports the combustion of a burning taper and of phosphorus, but extinguishes sulphur;—a powerful oxidizing agent.

Peroxide of nitrogen combines with nitric acid, which thereby acquires a strong orange tint, and constitutes the fuming-red *nitrous acid* of the shops, and the *nitroso-nitric acid* of Berzelius. The colour of the mixture varies with the strength of the nitric acid, becoming yellow, green, and blue, and finally disappearing altogether, as the quantity of water in the acid increases.

Nitric acid, NO_5;—procured synthetically, by passing a succession of electric sparks through a mixture of nitrogen and oxygen confined in a tube;—best prepared by the action of sulphuric acid on nitre (nitrate of potassa) with the aid of heat; nitric acid vapours pass over along with water, and the bisulphate of potassa remains in the retort: this constitutes the *aqua fortis* of commerce.

Prop.—When thus procured, liquid nitric acid is of a yellowish colour, which is dependent upon some nitrous acid fumes; when perfectly pure it is colourless; sp. gr. about 1·5; contains about 25 per cent. of water, without which it cannot exist as an *acid*, though it has lately been isolated in a dry crystalline form; emits dense, white, suffocating fumes when exposed to the air; boils at 187°. On adding different portions of water to the strong acid, several definite combinations of acid and water appear to be generated, remarkable for the difference observed in their boiling and freezing points.

The nitric acid of commerce is apt to contain traces of sulphuric and

hydrochloric acids; the former is detected by adding chloride of barium—an insoluble sulphate of baryta being precipitated; the latter, by nitrate of silver—an insoluble chloride of silver being thrown down. Nitric acid is a powerful oxidizer, acting with great violence on many of the metals; it decomposes all organic substances, and acts on the skin as a caustic. The salts formed by nitric acid are termed *nitrates.*

The best tests for nitric acid are,—its solvent power over gold, if hydrochloric acid be present; the formation of the well-known nitrate of potassa; the red tint communicated to a salt of morphia; and the bleaching effect upon a boiling solution of sulphate of indigo, provided no chlorine be present.

CARBON.

This is a very abundant product of nature, being a constituent of all organic bodies; its purest form is the diamond, a native crystal of carbon; which is proved to be pure carbon by burning it in oxygen gas, the sole product being carbonic acid. The next purest native variety is graphite or plumbago, which also contains some iron; next to this comes anthracite coal. It is the essential ingredient of common charcoal, which is prepared by burning wood in close vessels. *Coke* is the charcoal of bituminous coal; *lamp-black,* that of resin; *ivory-black* or animal charcoal is prepared from bones.

Prop.—Carbon, as it exists in the diamond, is the hardest substance in nature; it crystallizes in the form of the octohedron or cube; sp. gr. 3.52; is very unchangeable; bears an intense heat in close vessels without fusing; is not acted on either by acids or alkalies. As obtained from wood, it is hard and brittle; its apparent lightness is due to its porosity. It is a bad conductor of heat; a good conductor of electricity; and is very combustible, when burnt in the air or in oxygen, giving rise to carbonic acid; has the property of absorbing a large quantity of gases or vapours into its pores, though in very different proportions; thus, of ammonia, 90 times its volume is absorbed, while of hydrogen, it takes up less than twice its own bulk.

Another very useful property of charcoal is its power of absorbing the colouring matters from organic solutions; animal charcoal is best for this purpose. Charcoal is also highly antiseptic; it is hence used for purifying water in filtering machines; also to remove the odour from tainted flesh. The equivalent of carbon is 6·12; its symbol is C. It forms two direct compounds with oxygen, namely, carbonic oxide, and carbonic acid.

Carbonic oxide gas, CO. — Prepared by passing carbonic acid gas over red-hot charcoal or iron, one-half of its oxygen being removed and it becoming converted into carbonic oxide; or preferably by the action of sulphuric acid or oxalic acid (an organic acid consisting of equal measures of carbonic acid and carbonic oxide), which is immediately resolved into its constituents; and on passing the gases through a

strong solution of potassa, the carbonic acid is absorbed, and the carbonic oxide may be collected.

Prop. — Colourless and inodorous; sp. gr. 0·9927; sparingly absorbed by water; is neither acid nor alkaline; a non-supporter of combustion, but combustible, burning with a lambent blue flame, giving rise to carbonic acid; it is irrespirable. Mixed with oxygen it may be exploded by the electric spark, forming carbonic acid.

Carbonic acid, CO_2.—Discovered by Dr. Black in 1757, and named by him *fixed air;* prepared by the action of sulphuric or muriatic acid on any carbonate; the gas comes off with effervescence.

Prop.—Colourless; of a pungent odour and taste; very irrespirable; sp. gr. 1·524. It may be condensed into a liquid at 32° by a pressure of 36 atmospheres; this liquid may be frozen by the cold produced by its own evaporation, which is estimated at 148°. The liquefied acid is colourless, and limpid like water; the *solid* acid resembles snow. Carbonic acid acts upon animals as a poison, producing asphyxia; it is injurious even when largely diluted with air; hence the evils resulting from imperfect ventilation. It sometimes accumulates in wells and mines, constituting the *choke-damp* of miners. Water absorbs its own volume of this gas, at any pressure; consequently the amount absorbed is determined simply by the degree of pressure to which the gas is subjected; in this way carbonic acid water is manufactured. Carbonic acid exists in the air, as has been mentioned; also in common spring water, which owes to it its pleasant flavour; the gas may be entirely driven off by boiling; hence water which has been boiled is quite insipid. Its solution in water forms one of the great solvents of nature; by means of it, rocks are disintegrated and converted into soils. Its salts are numerous; they are named *carbonates*, the most common of which is *limestone.*

The best test for carbonic acid is *lime-water*, to which it always imparts a cloudiness, resulting from the formation of carbonate of lime. This may be seen also by breathing through a tube immersed in lime-water.

SULPHUR

Is found uncombined in the neighbourhood of volcanoes, as in Italy and Sicily; also abundantly in a state of combination with various metals, as iron, lead, copper, antimony, &c., constituting the *pyrites* of mineralogists. It is procured by exposing iron pyrites to a red heat, in close vessels.

Prop.—A yellow brittle solid, without odour and taste, under ordinary circumstances, but acquires a peculiar odour when rubbed; sp. gr. 1·99; a non-conductor of heat and electricity; melts at 232°, at which point it is a liquid of an amber colour. If the heat be increased it begins to thicken and acquires a reddish tint; between 428° and 482°, it is thickest; and beyond this it again becomes thinner up to its boiling point, 600°; burns when heated up to 300° in the open

air. The *roll brimstone* of commerce is melted sulphur run into cylindrical moulds. *Flowers of sulphur* are minute crystals of sulphur, obtained by subliming sulphur in close vessels. The sp. gr. of the vapour is 6.654. The vapour will support combustion. Crystals of sulphur may be procured by melting any quantity in an earthen vessel, and when partially cooled, breaking the crust and pouring out the liquid contents. Crystals are often found on breaking the roll brimstone of commerce.

Sulphur is insoluble in water; soluble in the fixed and volatile oils; the best solvent is the bisulphuret of carbon; it dissolves in alcohol if both substances are brought together in the state of vapour. Eq.=16. Symb. S.

It much resembles oxygen in its chemical habitudes, like that gas also generating both acids and bases.

Sulphur forms six compounds with oxygen, of which the most important are sulphurous and sulphuric acids.

Sulphurous acid, SO_2—the product when sulphur is burned in the open air, or in dry oxygen;—prepared conveniently by the action of sulphuric acid on mercury or copper; a part of the acid is decomposed, yielding up sulphurous acid and oxygen; the oxygen uniting with the metal.

Prop. Colourless; of a pungent, suffocating odour, and acid taste; sp. gr. 2·2105;—is condensed into a liquid at 45° by a pressure of two atmospheres, and at 0° under a pressure of one atmosphere;—a non-supporter of combustion, and a non-combustible;—cannot support respiration; water at 60° absorbs 32 times its volume. It possesses bleaching properties; its solution first reddening and then bleaching litmus. Its salts are termed *sulphites:* they are not of much importance.

Sulphuric acid, SO_3—Known in commerce as *oil of vitriol;*—may be procured in two modes: first, by exposing the protosulphate of iron (green vitriol) to a red heat, by which the sulphuric acid is driven off, and condensed, and the peroxide of iron remains. The acid thus procured is an oily brown liquid, of a sp. gr. of 1·9, fuming in the air, and very corrosive; it is known in commerce as *fuming sulphuric acid*, or *acid of Nordhausen*, from the place of its manufacture.

The second method is the one usually adopted. It depends upon the fact that when sulphurous acid and peroxide of nitrogen are present along with some water, the sulphurous acid takes oxygen from the peroxide of nitrogen, the first becoming sulphuric acid, and the last deutoxide of nitrogen. The mode adopted is the following: A mixture of sulphur and nitre is exposed to heat in such a manner, that the vapours are carried into a leaden chamber, upon the bottom of which is a stratum of water. The nitric acid of the nitre gives up oxygen to some of the sulphurous acid, thereby converting it into sulphuric acid, which immediately combines with the potassa; the greater part of the sulphurous acid enters the leaden chamber, when it comes

in contact with deutoxide of nitrogen, atmospheric oxygen, and watery vapours, forming a white crystalline compound, believed to be composed of sulphuric acid, nitrous acid, and water. When this solid falls into the water on the floor of the leaden chamber, it is decomposed into sulphuric acid (which is dissolved by the water), peroxide of nitrogen and deutoxide of nitrogen. The peroxide of nitrogen thus set free, as well as that produced by the reaction of the atmospheric oxygen on the deutoxide of nitrogen, is again mingled with sulphurous acid and watery vapours as before, and gives rise to the formation of another portion of the crystalline compound, which, in its turn, becomes decomposed on falling into the water. When the water in the leaden chamber becomes sufficiently saturated, it is drawn off and concentrated in platinum vessels, by heat, until it attains the sp. gr. of about 1·84.

The theory of the process may be expressed thus:—

Peroxide of Nitrogen.	Nitrogen 2 Oxygen 2 Oxygen	Deutoxide of Nitrogen.
2 Sulphurous acid.	2 Sulphur 4 Oxygen	
Water		2 Hydrated Sulph. acid.

Prop.—A dense, colourless, oily liquid, of an intensely sour taste and acid reaction;—consists of 40 parts, or 1 eq. anhydrous acid, and 9 parts or 1 eq. water;—extremely corrosive;—decomposes all organic substances; — has a powerful attraction for water, and when mixed with it gives rise to a great elevation in the temperature; freezes at—15° and boils at 620°.

Anhydrous sulphuric acid may be procured by heating the Nordhausen acid in a retort, to which is adapted a receiver surrounded with ice; a vapour passes over, which condenses into white silky crystals, resembling asbestos. It has such a strong affinity for water, that when put into that liquid it hisses like a hot iron; it is very volatile, boiling at 104°;—it does not display any acid reaction unless moisture be present. *Test,* chloride of barium.

Hyposulphurous acid, S_2O_2, cannot exist in an isolated form; it is produced when sulphur is digested in a solution of sulphate of potassa; —a *hyposulphite* of potassa is formed.

Hyposulphuric acid, S_2O_5, is procured in solution by suspending peroxide of manganese in water artificially cooled, and then transmitting through it a stream of sulphurous acid gas; the *hyposulphate* of the protoxide of manganese is thus formed, which is decomposed by baryta, and the barytic salt in its turn decomposed by sulphuric acid.

Two other acids of sulphur have recently been discovered, called respectively the *sulphuretted hyposulphuric acid,* S_3O_5, and *bisulphuretted hyposulphuric acid,* S_4O_5.

SELENIUM.

A very rare substance, much resembling sulphur in its chemical habitudes. It is a reddish brown solid body, having an imperfect metallic lustre, and a sp. gr. of 4·3;—melts at about 212° and boils at 650°. It forms an oxide and two acids.

PHOSPHORUS

Exists in bones and urine;—prepared from bones, in which it exists as phosphate of lime, by calcining, and then adding sulphuric acid and water; the sulphate of lime is precipitated, and the phosphoric acid left in solution with some of the lime, as a superphosphate. This is evaporated, mixed with charcoal and exposed to a high heat; the phosphorus distils over into water.

Prop.—When pure it much resembles wax, being soft and flexible, and of a flesh colour; sp. gr. 1.77;—fuses at 108°;—boils at 550°;—insoluble in water, but dissolves in naphtha and oils;—very inflammable;—burns with a bright flame generating phosphoric acid. It undergoes a slow combustion in the open air, giving a luminous appearance in the dark; this combustion may, however, be entirely prevented by the presence of olefiant gas, vapour of ether, or an essential oil. Eq.=15·7, or (according to some) 31·4. Symb. P.

Phosphorus forms four compounds with oxygen.

Oxide of phosphorus, P_2O, formed by melting phosphorus under hot water, and bringing a stream of oxygen gas in contact with it:—it has a red colour.—is insoluble in water, alcohol, or ether.

Hypophosphorous acid, PO, is formed when phosphuret of barium is put into water; it is a powerful deoxidizing agent.

Phosphorous acid, P_2O_3, or PO_3; formed by burning phosphorus in a limited supply of oxygen or air; in this state it is anhydrous, and is in the form of a white powder, very deliquescent. It forms *phosphites*, which are of little importance.

Phosphoric acid, PO_5; prepared by burning phosphorus in the open air or in oxygen, by which it is procured in the anhydrous form; also by heating phosphorus in nitric acid; also from bones, by acting on the phosphate of lime (which is formed as already described) by carbonate of ammonia, then evaporating the phosphate of ammonia, and heating in a platina crucible.

Prop.—Very deliquescent; is a powerful acid; very sour, but does not corrode like nitric and sulphuric acids. It is capable of existing in three different states or modifications, forming three separate classes of salts, which differ completely in properties and constitution. They are distinguished by the names *tribasic*, *bibasic*, and *monobasic* acids, according to the number of equivalents of base required to form neutral salts.

The *tribasic phosphoric acid* is the acid of the well-known phosphates; it is characterized by yielding with a soluble salt of silver, a yellow insoluble phosphate. It contains 3 eq. water.

The *bibasic phosphoric acid,* also called the *pyrophosphoric acid,* is procured by heating the former acid at a temperature of 415°;—it is distinguished from the tribasic acid by yielding a *white* instead of a yellow precipitate with the salts of silver. It contains 2 eq. of water.

The *monobasic phosphoric acid,* also named *paraphosphoric acid,* is procured when phosphorus is heated in the open air, and also when a concentrated solution of the tribasic or bibasic acids is heated to redness. By the former method, it is anhydrous; by the latter it is a hydrate. The hydrate is very fusible, and on cooling it condenses into a transparent brittle solid, called *glacial phosphoric acid,* which is very deliquescent. It contains 1 eq. of basic water. It forms an insoluble compound with albumen.

BORON

Is the basis of boracic acid;—may be procured from boracic acid by heating it with potassium; the oxygen of the acid, uniting with the potassium, sets the boron free.

Prop.—A dark olive-coloured substance; insoluble; a non-conductor of electricity; when burned in the open air or oxygen, it generates boracic acid. Eq.=10. Symb. B. It forms only one compound with oxygen, namely, *boracic* or *boric acid.* This can be procured by decomposing biborate of soda (borax) by means of sulphuric acid; the sulphate of soda remains in solution, and the boracic acid is deposited in the form of crystals.

It is sparingly soluble in cold water, more so in hot water, and very soluble in boiling alcohol. The alcoholic solution when set on fire, burns with a beautiful green flame,—a good test of its presence. When boracic acid is heated, it melts into a glassy mass.

The most important salt of boracic acid is *borax*—a biborate of soda, much used in blowpipe operations.

SILICON,

The basis of silex or silicic acid;—procured by heating the double fluoride of silicon and potassium; the latter combines with the fluorine, liberating the silicon.

Prop.—A dark brown powder, a non-conductor of electricity, and without the metallic lustre; heated in the air, it burns and is converted into silicic acid;—forms only one compound with oxygen. Eq.= 22·18. Symb. Si.

Silicic acid, SiO_3,—known also as silex or siliceous earth—exists abundantly in nature in the form of quartz and sand. Rock crystal is a very pure form of it.—Prepared by igniting transparent rock crystal, throwing it when red hot into water, and then reducing to powder; or by heating together powdered quartz or sand, and carbonate of soda: a silicate of soda is formed, which is to be boiled in

water; hydrochloric acid is then added, which combines with the soda, precipitating the silicic acid in the form of a gelatinous mass.

Prop.—A white powder, insoluble, tasteless; sp. gr. 2·69; very infusible; has no action on test paper on account of its insolubility; but it is a powerful acid, since it forms salts with the alkalies. Common glass is a silicate of potash. The best varieties of glass are made out of pure alkali and very fine sand, free from iron: flint-glass contains also some litharge or red lead. If the proportion be reversed, so as to have one part of silicic acid with three of potash, we have a soluble silicate of potash, called *liquor silicum*, or *liquor of flints*.

CHLORINE.

Chlorine, along with Iodine, Bromine, and Fluorine, forms a group of simple bodies whose chemical habitudes are remarkably similar. They, together with Cyanogen (a compound body), are termed *halogen bodies*, because they form salts resembling sea-salt, or chloride of sodium.

Chlorine exists abundantly in nature as an ingredient in common salt. It was discovered, in 1774, by Scheele, and by him called *dephlogisticated marine acid.* The French chemists named it *oxymuriatic acid*, from an opinion that it consisted of muriatic acid and oxygen. In 1809, Davy discovered its true nature, and gave to it the name of *chlorine*, from a Greek word signifying greenish-yellow. Prepared by the action of hydrochloric acid on peroxide of manganese, with the aid of heat; chlorine is set free, and water and a chloride of manganese are formed, thus:

2 Hydrochloric acid.	Chlorine Hydrogen Chlorine Hydrogen	Chlorine. 2 Water.
Peroxide of Manganese.	Oxygen Oxygen Manganese.	Chloride of Manganese.

Prop.—A yellowish-green gas, irrespirable, exciting strong spasms of the glottis;—sp. gr. 2·47; water at 60° absorbs twice its volume. It is best collected by conducting it, by means of a tube, into the bottom of tall receivers, the air being thereby displaced. The watery solution, on being exposed to the light, is slowly changed into chlorohydric acid, oxygen being set free. When moist chlorine is exposed to a cold of 32°, yellow crystals are formed, being a compound of chlorine and water. Chlorine is condensed into a liquid by a pressure of four atmospheres. It is a non-combustible, but a supporter of combustion; a lighted taper burns in it for a short time, but several of the metals, as antimony, tin, copper, and arsenic, take fire spontaneously when presented to it in a finely-divided state. In these cases, a *chloride* of the metal is formed. The strongest affinity of chlorine is for

hydrogen: it is in consequence of this that it acts so powerfully as a *bleaching* agent, water being always decomposed in the process, the hydrogen uniting with the chlorine to form chlorohydric acid, and the oxygen which is set free being the real decolorizing agent.

Chlorine is also useful as a *disinfecting* agent. The best test for chlorine is a soluble salt of silver;—a white insoluble chloride of silver is formed.

The non-acid compounds of chlorine are called *chlorides*. Eq.$=$36. Symb., Cl.

Chlorine forms *four* compounds with oxygen; none of them are very permanent, but they are all easily decomposed.

Hypochlorous acid, ClO, or protoxide of chlorine, is obtained by the action of chlorine gas on peroxide of mercury, thus:—

2 Chlorine	Chlorine	Chloride of Mercury.
	Chlorine	
Oxide of Mercury	Mercury	
	Oxygen	Hypochlorous acid.

It is a pale yellowish gas,—possesses powerful bleaching properties, and forms bleaching salts.

Chlorous acid, ClO_4, peroxide of chlorine;—prepared by heating a mixture of sulphuric acid and chlorate of potassa; the chloric acid which is set free is spontaneously decomposed into chlorous acid and hypochloric acid, the latter remaining in union with the potassa. It has a richer colour than chlorine, and is very explosive.

Chloric acid, ClO_5, the most important compound of the series;—prepared by adding sulphuric acid to the chlorate of baryta. If chlorine gas be transmitted through a solution of caustic potassa, a chlorate of potassa crystallizes, aud the chloride of potassium remains in solution. The chlorates are easily recognised;—they give out pure oxygen when heated, passing into chlorides; they yield chlorous acid on being heated with sulphuric acid; but give no precipitate with silver.

Perchloric acid, ClO_7, prepared by acting on the perchlorate of potassa with sulphuric acid. It has a very strong affinity for moisture, —forms salts resembling the chlorates.

Chloride of Nitrogen, ClN_4, prepared by transmitting chlorine gas through a solution of muriate of ammonia; globules of an oily aspect are formed, which subside to the bottom;—it is the most explosive substance known.

Chlorine also forms compounds with carbon, carbonic acid, phosphorus, boron, and silicon. The important compound of chlorine and hydrogen will be described subsequently.

IODINE

Exists in sea-weeds, and in certain saline springs;—usually prepared from *kelp*, an impure carbonate of soda; the mother waters of this con-

tain iodine in combination with sodium, or potassium. From this the iodine may be evolved by the action of sulphuric acid and peroxide of manganese; the rationale is as follows:—

Iodide of Sodium	Iodine	Iodine.
	Sodium	Sulphate of Soda.
2 Sulphuric acid	Sulphuric acid	
	Sulphuric acid	
Peroxide of Manganese	Oxygen	Sulphate of Manganese.
	Protoxide of Manganese.	

Prop.—A solid of a bluish-black colour, and metallic lustre; in crystalline scales;—sp. gr. 49; fuses at 225°; boils at 347°; colour of vapour a rich violet; slowly volatile at common temperatures, exhaling an odour resembling that of chlorine; density of vapour 8·716, being the heaviest of all vapours; very sparingly soluble in water, but soluble in alcohol. The best *test* for iodine is starch, with which it forms a blue compound.

The affinities of iodine are not so strong as those of chlorine, since the latter always displaces iodine from its compounds.

The non-acid compounds of iodine are called *iodides.*—Eq.=126. Symb. I.

Iodine forms at least two compounds with oxygen.

Iodic acid, IO_5, forms iodates.

Periodic acid, IO_7.

Iodine forms a compound with chlorine, the *chloride of iodine;*—also with nitrogen, a very explosive compound, similar to the chloride of nitrogen;—also with phosphorus and sulphur.

BROMINE

Is found in sea-water as a bromine of magnesium; also in certain saline springs;—procured from bromide of potassium by sulphuric acid and peroxide of manganese: the reaction is precisely similar to that in the case of iodine.

Prop.—A very volatile liquid, of a deep reddish-brown colour; freezes a little below 0°; boils at 116°; odour very suffocating and offensive; slightly soluble in water; more so in alcohol and ether. The aqueous solution bleaches. It is very poisonous; its chemical habitudes are closely allied to those of chlorine and iodine; it forms compounds with oxygen, chlorine, iodine, hydrogen, sulphur, phosphorus, carbon, and silicon.—Eq.=78·4. Symb. Br.

FLUORINE

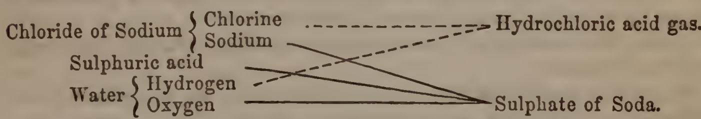
Occurs in nature in combination with calcium, in the well-known *fluor spar;* has only lately been isolated, on account of its energetic affinities. It is a yellowish gas, with an odour resembling chlorine;—has a powerful affinity for hydrogen and the metals; sp. gr. 1·289;—Eq.=18·68. Symb. Fl. Its compounds with hydrogen, silicon, and boron will be described in the subsequent section.

SECTION II.

COMPOUNDS OF SOME OF THE FOREGOING SIMPLE SUBSTANCES WITH EACH OTHER.

COMPOUNDS OF HYDROGEN.

Chlorine and Hydrogen;—Hydrochloric acid, Chlorohydric acid, or *Muriatic acid,* HCl;—prepared by the action of dilute sulphuric acid on chloride of sodium, according to the following rationale:



Prop.—A colourless gas; gives off dense fumes on exposure to the air; has a very powerful affinity for water, and hence must be collected over mercury; condensed into a liquid by a pressure of 40 atmospheres; sp. gr. 1·269; water absorbs 418 times its bulk.

The solution of this gas in water constitutes the *muriatic acid* of commerce. This, when pure, is colourless; but usually has a light straw colour—due to impurities, as iron, nitric and sulphuric acids, &c. When mixed with nitric acid it forms *aqua regia*, which has the property of dissolving gold, in consequence of the chlorine evolved; water and peroxide of nitrogen are also formed at the same time. Water is essential to develop the acid properties of this acid. Strictly speaking, it is a *chloride of hydrogen;* and when added to a metal, its hydrogen is simply displaced by the latter.

Hydrogen and Iodine.—Hydriodic acid, HI.—A gas much resembling hydrochloric acid;—prepared by heating water in union with iodide of phosphorus; the hydrogen combines with the iodine, to form hydriodic acid, and the oxygen with the phosphorus, to form phosphoric acid.

Prop.—Colourless; acid; has a strong affinity for moisture, and gives out white fumes in the air. It is decomposed by chlorine, with the formation of hydrochloric acid, and evolution of iodine; sulphuric and nitric acid also decompose it by imparting oxygen, likewise evolving iodine.

Hydrogen and Bromine.—Hydrobromic acid, HBr;—prepared like hydriodic acid, from a bromide of phosphorus.

Prop.—A colourless gas, irrespirable, acid; is decomposed by chlorine, but not by iodine.

Hydrogen and Fluorine.—Hydrofluoric acid, HFl;—prepared by the action of dilute sulphuric acid on fluoride of calcium (fluor spar);

the chemical changes are analogous to those occurring in the preparation of hydrochloric acid.

Prop. — At 32° it is a colourless liquid, but when exposed to the air, it flies off in dense white fumes; sp. gr. 1·0609; — its affinity for water surpasses even that of sulphuric acid, the combination being accompanied with a hissing noise; its vapour is extremely pungent; it is very destructive to organized bodies, as the skin, upon which it produces a deep and painful ulcer. It acts powerfully on glass, forming with it a fluosilicic acid; on this account it must be prepared in metallic vessels. From its affinity for glass, it may be used for etching on that substance; the glass being coated with a thin film of wax and the figures traced with a pointed instrument; it is then submitted to the action of the gas, which, acting only on the exposed portions of the glass, leaves an indelible mark upon them.

Under this head it will be convenient to allude to some other compounds of fluorine.

Fluosilicic acid, or *Fluoride of Silicon*, SiFl,—is formed whenever hydrofluoric acid comes in contact with glass; it is best made by heating a mixture of powdered fluor spar and glass with strong sulphuric acid: the changes are as follows: — the hydrofluoric acid (generated by the action of the sulphuric acid on fluoride of calcium; reacts with the silicic acid of the glass so as to form water and fluosilicic acid, thus :—

Hydrofluoric acid	Fluorine	Fluosilicic acid.
	Hydrogen	
Silicic acid	Silicon	
	Oxygen	Water.

Prop. — A colourless, irritating gas, producing white fumes on escape into the air, from the action of moisture; is decomposed by water into pure silicic acid, which is deposited in flakes, and into a new acid termed *hydrofluosilicic* acid — a compound of hydrofluoric and fluosilicic acids.

Fluoboric acid, BFl_3.—Prepared by heating a mixture of powdered fluoride of calcium and vitrified boracic acid together; fluoboric acid and lime are generated.

Prop.—A colourless, pungent gas; decomposed by water into boracic acid and *borohydrofluoric* acid.

Hydrogen and Nitrogen. — *Ammonia*, or *volatile alkali*, NH_3. — Prepared by heating a mixture of powdered sal ammoniac and quick lime; by a double decomposition we have gaseous ammonia, chloride of calcium, and water, thus :

Sal ammoniac	Ammonia		Ammonia.
	Hydrochloric acid	Chlorine	Chloride of Calcium.
		Hydrogen	
Lime . . .		Calcium	
		Oxygen	Water.

Prop. — A colourless gas, of a strong and pungent odour; very rapidly absorbed by water (more than 700 times its own volume); sp. gr. ·589; has a powerful alkaline reaction; is condensed into a liquid under a pressure of 6·5 atmospheres at 60°; cannot be formed artificially by a direct union of its elements, but is an abundant product of the putrefaction of animal substances; it may be decomposed by the electric spark, by chlorine, and by being passed through a red-hot porcelain tube.

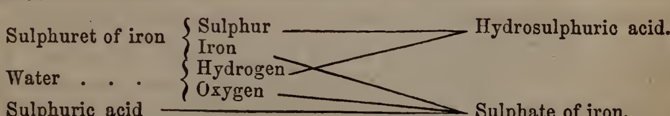
The solution of ammonia (*aqua ammoniæ*) may be prepared by simply saturating water with gaseous ammonia; it is colourless, and possesses the pungent odour and alkaline reaction of the gas.

Ammonia forms salts with the different acids, which are all decomposed by a red heat, and by a less powerful heat, if they are mixed with an alkali or alkaline earth. The ammoniacal salts were formerly considered to be formed by a direct union of the alkali and the acid; but, at present, the acid is believed to unite with the oxide of a hypothetical metal termed *ammonium.* This supposed metal has never been isolated, but is inferred to exist from the fact that when ammonia is decomposed by a galvanic current, and the negative wire terminates in some mercury, an amalgam is formed, having all the characters of an ordinary metallic amalgam; but when left to itself, this amalgam rapidly decomposes into mercury, hydrogen, and nitrogen. Ammonium is believed to be composed of ammonia and one eq. of hydrogen; it is represented by NH_4, and the base of the ammoniacal salts would consequently be represented by NH_4O.

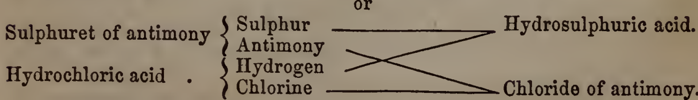
The most important of these salts are the *chloride of ammonium* (sal ammoniac), the *carbonates,* the *nitrate,* and the *sulphate.*

There is believed to be yet another compound of hydrogen and nitrogen, to which the name of *amide,* or *amidogen,* is given. Like ammonium, it has never been isolated: it is represented by NH_2.

Hydrogen and Sulphur. — *Sulphuretted hydrogen, Hydrosulphuric acid,* HS.—Conveniently prepared by the action of dilute sulphuric acid on sulphuret of iron; or by chlorohydric acid on sulphate of antimony, as follows:—



or



Prop. — A colourless gas, having the odour of rotten eggs; irrespirable, acting as a narcotic; combustible, burning with a blue flame, producing water and sulphurous acid; a non-supporter of combustion;

becomes a liquid under a pressure of 17 atmospheres; is decomposed by chlorine, with a deposition of sulphur; sp. gr. 1·171; it has the properties of a weak acid, reddening litmus paper, and forming salts.

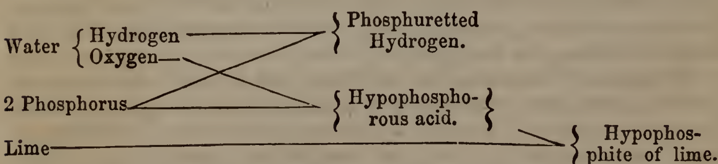
The best *test* is acetate of lead, with which it forms the black sulphuret of lead.

Hydrosulphuric acid is valuable to the chemist as a test for metallic solutions, causing with them an insoluble precipitate of the sulphuret of the metal.

There is another compound of sulphur and hydrogen, called *persulphuret of hydrogen*, HS_2.

Hydrogen and Selenium.—Hydroselenic acid, HSe;—in its general properties it resembles hydrosulphuric acid.

Hydrogen and Phosphorus.—Phosphuretted hydrogen, PH_3, prepared by boiling together hydrate of lime, water, and phosphorus; the water is decomposed, and hypophosphite of lime and phosphuretted hydrogen are formed, thus:—



The most remarkable feature of this gas is its spontaneous inflammability; so that if the beak of the retort in which it is evolved be placed under water, as each bubble of gas rises through the liquid it takes fire, and forms a beautiful ring of a dense white smoke, which enlarges as it ascends, consisting of phosphoric acid and watery vapour.

COMPOUNDS OF CARBON AND HYDROGEN.

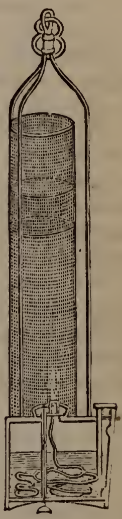
The number of these compounds has now become very great; but most of them belong properly to the domain of organic chemistry; two of them, however, are generally considered under the head of inorganic chemistry: these are Light carburetted hydrogen and Olefiant gas.

Light carburetted hydrogen, marsh gas, fire-damp, dicarburet of hydrogen, CH_2;—is formed in stagnant pools by the decomposition of vegetable matters; and may be procured by stirring up the mud at the bottom of the pool, and collecting the gas. It may be prepared by strongly heating a mixture of acetate of soda, hydrate of potash, and quicklime: the gas is derived from the decomposition of the acetic acid and water.

Prop.—Colourless, tasteless, nearly inodorous; a non-supporter of combustion or respiration, but very combustible, burning with a bright yellow flame;—mixed with oxygen in due proportions, it forms an explosive mixture; products of its explosion or combustion, water and

carbonic acid; sp. gr. ·559. This gas is frequently evolved in large quantities from coal mines, and explodes on contact with the flame of the miners' lamp, causing the most disastrous consequences. Sir H. Davy's *safety-lamp* was invented to obviate these fatal results. It consists of a common oil-lamp, enclosed in a cage of wire-gauze, made double at the upper part, containing about 400 apertures to the square inch. When this lamp is taken into an explosive mixture, although the fire-damp, passing inside the gauze, may burn within the cage with such energy as to heat the metallic tissue to redness, the flame is not communicated to the mixture on the outside, in consequence of the cooling effect produced upon the heated gas by the wire-gauze; most fortunately, the fire-damp has a very high kindling point; it will not inflame at the red heat of wire-gauze.

Fig. 342.



Chlorine does not act on light carburetted hydrogen, if kept in the dark; but if the light be admitted, a combination ensues, attended with the formation of hydrochloric and carbonic acids.

Olefiant gas, C_2H_2;—so called from its property of forming an oil-like liquid with chlorine. Prepared by heating a mixture of strong sulphuric acid and alcohol; at first ether is formed, and comes over along with vapour of alcohol; afterwards the olefiant gas comes over along with sulphurous and carbonic acid; the two latter are to be absorbed by potassa.

Prop.—Colourless, tasteless and inodorous; water absorbs about one-eighth of its volume; a non-supporter of combustion and respiration, but burns with a dense bright light, producing carbonic acid and water. Mixed with a due proportion of oxygen, it explodes by means of the electric spark. Sp. gr. ·981. Mixed with chlorine, it combines with it in equal measures, forming a heavy, oily liquid, of sweetish taste and ethereal odour, termed *Dutch liquid.*

Flame is gas heated to a white heat. It owes its *light* to the presence of solid particles of carbon, there not being sufficient oxygen to consume them. Hydrogen yields an intensely hot flame, but emits but a feeble light, because it contains no solid matter.

The gas employed for illuminating purposes is usually made from coal, oil, resin, and other organic substances containing a large quantity of carbon and hydrogen. The coal is distilled in cast iron retorts, maintained at a bright red heat; and the volatilized products conducted through long pipes into receptacles where it is purified by means of hydrate of lime. Coal gas contains a number of different principles, as light carburetted hydrogen, olefiant gas, hydrogen, carbonic oxide, nitrogen, and some other volatile substances. Besides these, a number of other matters are separated in the processes of con-

densation and purification, as tar, sulphuretted hydrogen, sulphate of ammonia, &c. The relative illuminating power of different varieties of coal and oil gas depends upon the relative amount of carbon and hydrogen contained; the light being greatest when these are in excess, provided always, there be enough oxygen to burn them completely.

COMPOUNDS OF NITROGEN AND CARBON.

Cyanogen, Bicarburet of nitrogen, NC_2 or Cy. Prepared by heating in a retort the bicyanide of mercury; the cyanogen passes off in the form of a gas, and the mercury sublimes.

Prop.—Colourless, of a strong and peculiar odour; condenses into a liquid at 45° under a pressure of 3·6 atmospheres; a non-supporter of combustion, but inflammable, burning with a characteristic purple flame, producing nitrogen and carbonic acid. Water absorbs four or five times its volume, and alcohol much more;—sp. gr. 1·806.

Paracyanogen is the name given to the black matter left in the retort after the preparation of cyanogen.

Tests.—The peculiar odour; the white precipitate formed with silver; the blue compound obtained by heating it with an alkali and a persalt of iron.

Cyanogen and Hydrogen.—Hydrocyanic acid, Cyanhydric acid, Prussic acid, CyH. Prepared in the anhydrous form, by passing sulphuretted hydrogen over fragments of bicyanide of mercury, contained in a horizontal glass tube, and receiving the product in a vessel surrounded with a freezing mixture. Gentle heat is applied to the tube, and the cyanogen reacting with the sulphuretted hydrogen, produces hydrocyanic acid and the sulphuret of mercury.

Prop. — A thin, colourless liquid, exceedingly volatile; sp. gr. ·7058; boils at 79° and freezes at 0°; has a powerful characteristic odour of peach blossoms or oil of bitter almonds; has a very feeble acid reaction; unites with water and alcohol in all proportions. In its anhydrous state it is one of the most poisonous substances known, a single drop being sufficient to kill a large dog. The best antidotes are chlorine and ammonia. It is very liable to decomposition, especially if exposed to the light.

The *solution* of hydrocyanic acid is best prepared by the action of dilute sulphuric acid on the ferrocyanide of potassium. Also by the action of hydrochloric acid on the cyanide of silver suspended in water, or by the action of tartaric acid on cyanide of potassium and water.

Hydrocyanic acid is an organic product, being frequently met with in the vegetable kingdom. It is believed, however, not to pre-exist in vegetables, but to be due to the mutual reaction of two organic principles, named *amygdaline* and *emulsine* or *synaptase,* with water.

Cyanic Acid, CyO,—may be prepared from cyanate of potassa.

Prop.—A limpid, colourless liquid, with a pungent odour. With ammonia it forms a compound isomeric with *urea*.

Fulminic Acid, Cy_2O_2, is developed by the action of nitrous acid on alcohol in the presence of either silver or mercury. These *fulminates* are violently explosive.

Cyanuric Acid, Cy_3O_3, is isomeric with the two others.

CHAPTER II.

SECTION I.

METALS.

GENERAL PROPERTIES.

THEY are all conductors of heat and electricity; they are positive electrics; they are opaque; possess generally a well-marked lustre, termed *metallic;* and are generally good reflectors of light. The number generally admitted by chemists is fifty-two. Some of them are of very rare occurrence. They vary greatly in specific gravity,—between potassium, which is lighter than water, and platinum, which is twenty-one times heavier.

Properties which are peculiar to certain metals.—Malleability, ductility, tenacity, the welding process, hardness, and the crystalline structure.

All are solid at common temperatures, except mercury. Their fusing point varies very much—ranging between mercury, which is — 39°, and platinum, which is infusible at the heat of a smith's forge.

Metals often unite together to form *alloys*. When mercury unites with another metal, the compound is named an *amalgam*. Examples of alloys are *brass*, from copper and zinc; *bronze*, from copper and tin; *bell-metal*, from copper and tin; *type-metal*, from antimony and lead; *solder*, from tin and lead. Gold and silver coins are also alloys. Many of the alloys occur native.

But few of the metals are found native, that is, in their uncombined form. They usually are united with either oxygen or sulphur, or else they occur as salts.

Metals differ greatly in their attraction for oxygen; some have such a powerful affinity for this agent, that they decompose water, in order to unite with it. On the other hand, gold, silver, and platinum are very difficult to oxidize. The term *noble* has been given to such metals as are not liable to tarnish on exposure to the air.

Most metals may be oxidized by exposure to heat in the open air. This process was formerly termed *calcination;* and the product formed a *calx.* Another mode of oxidizing is by *deflagration*, or by heating with nitrate of potassa, or chlorate of potassa. Nitric and nitro-hydrochloric acids are also powerful oxidizing agents.

Metallic oxides may be *reduced* either by heat alone, as in the case of the oxides of the noble metals, or by the united agency of heat and combustible matter, as hydrogen, charcoal, and the *black flux;* or by galvanism, which is still more powerful; or by the agency of deoxidizing agents, as phosphorous acid, protochloride of tin, &c.; or by precipitation from their solutions by means of other metals: thus silver is thrown down from a solution of its nitrate by means of mercury; copper, by means of iron, and so on.

The compounds of metals with oxygen, are for the most part *oxides;* occasionally they are *acids.* Arsenic is the only one which forms an acid, without, at the same time, forming an oxide. Most of the metallic oxides act as *salifiable bases*—that is, they form salts with acids. Generally, but not always, this property is confined to the *protoxides.*

Chlorine, bromine, iodine, and fluorine have also a strong affinity for metals,—particularly the two former.

Sulphur has a strong tendency to unite with metals: the combination may be effected either by heating the powdered metal and sulphur together; by igniting together a metallic oxide and sulphur; by heating a sulphate, along with combustible matter, by means of which the oxygen is removed in the form of carbonic acid; or by the action of hydrosulphuric acid. Several of the metallic sulphurets (sulphides) occur native, as of lead, antimony, iron, zinc, &c.

The compounds of selenium and the metals closely resemble the sulphurets.

Phosphorus and hydrogen occasionally unite with the metals.

Before describing metals individually, it may be proper to bestow a few remarks on the subjects of *Salts* and *Crystallization.*

SECTION II.

SALTS.

THE term *salt* was formerly restricted to a compound of an acid and a salifiable base; but this definition was necessarily vague, on account of the difficulty of always accurately defining what was an acid, and what was a base. Formerly, an acid was considered to be "an oxidized body which has a sour taste, reddens litmus, and neutralizes alkalies." Subsequent discovery showed the propriety of extending this

definition; for, first, the discovery of the hydracids proved that oxygen is not essential to acidity; and secondly, some compounds, owing to their insolubility, have neither a sour taste, nor do they redden litmus, yet they neutralise bases; thirdly, there are some acknowledged acids, as carbonic, hydrocyanic, &c., which are unable fully to destroy the alkalinity of potassa.

Chemists of the present day agree to call all such bodies *acid* which unite with potassa or ammonia, and give rise to bodies similar in constitution and general character to the salts which sulphuric or some other admitted acid forms. For similar reasons, the present notion of what constitutes an *alkaline* or *salifiable base*, is that of a body which unites definitely with admitted acids, to form with them compounds resembling recognised salts.

There is a very important class of compounds, which, however, would not fall within the range of the above definition of a salt; and which yet have undoubted claims to be considered as such: they comprise the chlorides, iodides, bromides, &c., and are named *haloid* salts, from a Greek word signifying *sea-salt*.

The notion of a salt has been still farther extended. It is known that two metallic sulphurets occasionally unite together to form a compound called a *double sulphuret*. To such compounds Berzelius gave the name of *sulphur-salts*. They are precisely analogous in their composition to a common oxy-salt, as may be seen by simply substituting for the sulphur an equivalent quantity of oxygen. In these salts, the *sulphur-acid* is a sulphuret of some one of the electro-negative metals, as arsenic, antimony, tungsten, &c.; the *sulphur-base* is a sulphuret of an electro-positive metal, as potassium, sodium, mercury, &c.

It has also been found that the haloid salts will unite together, to form what is termed a *double haloid salt;* which also may be considered precisely analogous to an oxy-salt, the halogen element (chlorine, iodine, &c.), simply taking the place of oxygen.

Thus we may make two generic divisions of salts into 1, *amphigen salts*, or those which are formed from amphigen bodies (oxygen, sulphur, selenium, and tellurium), and 2, *halogen salts*, or those containing a halogen body (chlorine, iodine, bromine, fluorine, and cyanogen).

By a *double salt* is meant one in which the same acid is united with two separate bases, as tartar emetic (tartrate of oxide of antimony and potassa).

Nearly all salts are solid at common temperatures; most are capable of crystallizing; their colour is variable; the soluble ones are more or less sapid; very few are odorous. They differ much in their affinity for water: some attract moisture from the air and become liquid; such salts are called *deliquescent*. They differ also very much in their solubility in water, which is in the direct ratio of their affinity for water, and in the inverse ratio of their cohesion. In many salts water acts as a base, and is hence termed *basic water*.

As a general rule, every salt has its own distinct *crystalline form*,

by which it may be recognised. Crystallization may be effected in various ways, as by solution and evaporation: the slower the evaporation, the larger and more regular the crystals; if the evaporation be made very rapid by heat, a confused crystalline mass is obtained. Fusion and slow cooling may sometimes be employed; thus crystals of sulphur and bismuth may be procured. A third condition under which crystals form, is in passing from the gaseous to the solid state, as in the case of iodine.

Many salts, in crystallizing, unite chemically with a definite portion of water, which belongs to the crystal, but not to the salt; this is termed *water of crystallization.* By a strong heat, all this water is expelled, and the salt is said to undergo the *watery fusion.* Such salts, when exposed to the air, are liable to part with a portion of this water, and crumble down into a powder; they are said then to be *efflorescent.* Others contain water even more intimately connected with them, and termed *constitutional water.*

Some salts, again, in crystallizing, enclose a portion of water mechanically within their texture; which, by its expansion, when the salt is heated, causes it to burst with a crackling noise; this is termed *decrepitation.*

Atmospheric pressure exerts an influence on the crystallization of salts; if, for instance, a hot saturated solution of sulphate of soda be corked up in a bottle while the latter is full of vapour, the solution will cool down to the temperature of the air without crystallizing; but on admitting the air, crystallization commonly commences, and the whole becomes solid in a few seconds.

Crystals are of various forms: they are divided by crystallographers into *simple* and *compound.* By *cleavage* is meant that property of a crystal by which it admits of being split in certain directions.

Bodies are said to be *isomorphous* when they have the same crystalline structure, but a different chemical composition: thus arseniate of soda is isomorphous with phosphate of soda. On the other hand, the same substance may have, under different circumstances, two crystalline forms; in which case it is said to be *dimorphous:* sulphur and carbon are examples. The instrument employed to ascertain the angles of crystals is termed a *goniometer.*

SECTION III.

OXYSALTS.

This class of salts includes those, of which both the acid and base are oxides. It will be convenient to classify them according to their different acids.

SULPHATES.

Their solutions may always be recognised by yielding a white precipitate (sulphate of baryta), with a solution of a salt of baryta. Heated in contact with charcoal or hydrogen they are converted into sulphides, which, if moistened, yield the peculiar odour of sulphuretted hydrogen. They are almost all insoluble in alcohol. The sulphates of baryta, tin, antimony, lead and bismuth, are quite insoluble in water. Those of lime, strontia, mercury, silver, and a few others, are nearly insoluble; while all the other sulphates are soluble.

The most important sulphates are those of potassa, soda, magnesia, lime, baryta, iron, copper, zinc, and mercury.

The most important *double sulphates* are the different *alums*. Common alum is a double sulphate of alumina and potassa. It may be prepared from native *alum stone*, in which the materials exist ready formed, or from a direct union of its constituents.

There are other varieties of alum, in which the sulphate of potassa is replaced by sulphate of soda, or sulphate of ammonia;—also *iron* and *manganese* alums, in which the sulphate of alumina is replaced respectively by the sulphate of iron and the sulphate of manganese.

The *Sulphites*, *Hyposulphites*, and *Hyposulphates*, are of very little practical importance.

NITRATES.

These may be prepared by the action of nitric acid on metals,—on the salifiable bases,—or on the carbonates. As they are soluble salts, their acid cannot be precipitated by any reagent. They are distinguished by deflagrating with charcoal, and other combustibles. When exposed to a high temperature, they are decomposed with the evolution of oxygen gas. If subjected to the action of sulphuric acid, they give off nitric acid fumes. When added to hydrochloric acid they form a solvent for gold leaf, by liberating the chlorine.

The most important nitrates are those of potassa, soda, ammonia, copper, mercury, and silver.

The *Nitrites* are comparatively unimportant.

CHLORATES.

These are very analogous to the nitrates. They are all decomposed by a red heat into metallic chlorides and oxygen gas. They deflagrate with combustibles even more violently than the nitrates. They are nearly all soluble in water.

The most important salt of this class is the *chlorate of potassa*, which is useful to the chemist in the preparation of oxygen.

The *Chlorites* are chiefly remarkable for their bleaching and oxidizing properties.

The *Hypochlorites* may be produced by the action of chlorine gas

upon salifiable bases. The most important of them is the *hypochlorite of lime*, the well-known bleaching-powder, commonly called chloride of lime. It is prepared by exposing thin strata of recently-slaked lime to an atmosphere of chlorine: the chloride of calcium and hypochlorite of lime are formed.

IODATES.

These are compounds of iodic acid and a base. They bear a general resemblance to the chlorates, and may be recognised by the facility with which they are decomposed by deoxidizing agents, as hydrochloric, sulphurous, and phosphorous acids, which unite with the oxygen, setting iodine free.

The *Bromates* generally resemble the iodates.

PHOSPHATES.

As regards this class of salts, it is to be remembered that there are three isomeric phosphoric acids, termed *tribasic*, *bibasic*, and *monobasic*, or *phosphoric*, *pyrophosphoric*, and *metaphosphoric* acids. Each one of these modifications forms its own peculiar salts, the tests for which were spoken of under the head of Phosphorus. The most important phosphates are those of soda, lime, ammonia, lead, and silver.

CARBONATES.

These are distinguished by their facility of decomposition by any of the acids, with effervescence. All the alkaline carbonates are decomposable by heat, except those of potassa, soda, baryta, strontia, and probably lithia. All except those of potassa, soda, and ammonia, are sparingly soluble in water; but are more or less soluble in an excess of carbonic acids. Several of the carbonates occur native, as those of lime, magnesia, soda, baryta, iron, copper, and lead.

The most important carbonates are those of potassa, soda, lime, ammonia, magnesia, baryta, iron, copper, and lead.

ARSENITES AND ARSENIATES.

These are salts of arsenious and arsenic acids respectively. The *arsenites* are all decomposed by a red heat, the arsenious acid being either dissipated in the form of vapour, or converted into arsenic acid.

The *arseniates* are not so easily decomposed, requiring usually along with heat the aid of charcoal, or black flux.

CHROMATES.

The salts of chromic acid are mostly of a yellow or red colour, the latter tint predominating whenever the acid is in excess. They are valuable as pigments. The most important of the chromates are those of potassa and lead.

BORATES.

The salts of boracic acid are very easily decomposed. The most important one is the *biborate of soda*, or common borax. They may all be recognised by their solutions in strong alcohol, burning with a greenish flame.

SECTION IV.

HYDROSALTS.

By this term is understood such salts, of which either the acid or base contains hydrogen. Formerly, this class of salts was much more extensive than it is at present, in consequence of the different views taken of the composition of the so-called *muriates*, or *hydrochlorates*, but which are now generally spoken of as chlorides. Indeed, all the haloid salts are now considered as compounds of the halogen element (chlorine, iodine, bromine, &c.,) with a metal, rather than as compounds of a hydracid with the oxide of the metal, which was the former view. According to the present doctrine, when a hydracid is presented to any salifiable base, both are decomposed, water and a haloid salt of the metal being formed. Take hydrochloric acid and potash by way of example.

Hydrochloric acid { Chlorine — Chloride of potassium.
{ Hydrogen
Potash . . . { Potassium
{ Oxygen — Water.

The only hydro-salts which are now at all recognised are the compounds of ammonia with a hydracid; though even these might be considered as haloid salts of the hypothetical metal *ammonium*. This will be evident by the following diagram:—

Hydrochloric acid { Chlorine — Chlorine } Sal ammoniac.
{ Hydrogen
Ammonia . . { 3 Hydrogen
{ Nitrogen — Ammonium

The most important of the ammoniacal salts are the *hydrochlorate*, commonly called sal ammoniac, and the *hydrosulphate*, formerly termed the *fuming liquor of Boyle*.

SECTION V.

SULPHUR SALTS.

The sulphur salts are double sulphurets, just as the oxy-salts are double oxides; the sulphuret of one metal acting as an acid, while the sulphuret of another metal acts as a base. The sulphur salts are so constituted, that if the sulphur in both the acid and base was replaced by oxygen, an oxy-salt would result.

The principal *sulphur-bases* are, the protosulphurets of potassium, sodium, lithium, barium, strontium, calcium, and magnesium; and the principal *sulphur-acids* are the sulphurets of arsenic, tin, antimony, tungsten, molybdenum, tellurium, and gold, together with hydrosulphuric acid, and bisulphuret of carbon. Kermes' mineral, an important antimonial medicine, is an example of a sulphur salt, being composed chiefly of sulphuret of antimony, united with sulphuret of potassium.

SECTION VI.

DOUBLE HALOID SALTS.

These salts are composed of two simple haloid salts, one of which acts as an acid, and the other as a base, in a manner analogous to the double sulphurets. The principal groups consist of double chlorides, double iodides, and double fluorides.

When an oxide and chloride unite, they constitute a compound known by the name of *oxy-chloride*.

CHAPTER III.

CLASSIFICATION OF THE METALS.

Class I. Metals of the Alkalies.
Class II. Metals of the Alkaline Earths.
Class III. Metals of the Earths.
Class IV. Metals proper.

SECTION I.

CLASS I.

METALS OF THE ALKALIES.

The metals of the alkalies are *Potassium*, *Sodium*, *Lithium*, and *Ammonium*.

POTASSIUM.

Discovered in 1807 by Davy, by the agency of galvanism.—Prepared by exposing a mixture of carbonate of potash and charcoal to a high heat, in a gun-barrel; the potassium distils over, leaving carbonic oxide, thus:

$$\begin{array}{ll} \text{1 eq. Carbonate of potassa} \left\{ \begin{array}{l} K \\ O \\ CO_2 \end{array} \right. & \\ \text{2 eq. Carbon, 2 C} & \longrightarrow 3\ CO. \end{array}$$

Prop.—Solid at ordinary temperatures,—soft and malleable between the fingers—of a white colour and metallic lustre—brittle at 32°,—melts at 150°; sp. gr. ·865,—has a powerful affinity for oxygen;—cannot be kept in the air or water;—preserved under naphtha or oil of copavia. It takes fire when thrown on water, with the disengagement of hydrogen, which combines with a portion of the potassium, forming potassiuretted hydrogen, which also takes fire, increasing the brilliancy of the flame;—potash is formed as the result. The equivalent of potassium (Kalium) is 39·15; its Symbol K.

It forms two compounds with oxygen, potash, KO, and the peroxide, KO_3.

Protoxide of potassium or *potash*, is formed whenever potassium is exposed to air or water. In the anhydrous form, it is a white solid, very caustic; has a strong affinity for water, with which it forms a hydrate.

The *hydrate of potassa*, KO+HO, also named *common caustic*, and *potassa fusa*, is prepared by decomposing carbonate of potash by lime; the carbonate of lime is thrown down, and the potassa remains

in solution; this is concentrated by heat, and then poured out into moulds. Pure hydrate of potassa is a white solid, very deliquescent, soluble in water and alcohol. The common caustic potash may be purified by dissolving in alcohol. The solution, like lime water, rapidly absorbs carbonic acid from the air. The solid hydrate, from its affinity for water, is used to free gases from hygrometric moisture.

Peroxide of potassium, KO_3, is formed when potassium is burned in dry oxygen, or in the open air; it is of an orange colour.

The most important salts of potassa are the *nitrates*, the *carbonates*, the *sulphates*, and the *chlorate*. The impure carbonate (*pot* and *pearl ashes*) is produced by lixiviating the ashes of inland plants, and evaporating to dryness; it is purified by redissolving in water, and boiling. The pure carbonate (salt of tartar) is made by decomposing cream of tartar by a high heat. Composition, $KO+CO_2$.

The *bicarbonate*, $KO+2CO_2+HO$, is formed by passing a stream of carbonic acid through a solution of the carbonate. It is not so soluble as the carbonate.—A *sesquicarbonate* is said to exist.

The *sulphate*, $KO+SO_3$, is the residue left in the retort in the preparation of nitric acid. The *bisulphate*, $KO+2SO_3$, is more soluble, and has an acid taste and reaction. There is also a *sesquisulphate.*

The *nitrate*, $KO+NO_5$, named also *nitre* and *saltpetre*, occurs native, as an effloresence on certain salts; it is manufactured also from artificial nitre-beds. Shape of crystals, six-sided prisms;—very soluble;—contains water mechanically confined, which causes the crystals to *decrepitate* when thrown upon hot coals. When heated, it gives off oxygen, and is converted into a *hyponitrite;* a high heat entirely decomposes it. From its power of imparting oxygen, it is the active ingredient in *gunpowder*, which is a mixture of nitre, charcoal, and sulphur. When gunpowder is fired, the oxygen of the nitre combines with the carbon to form carbonic oxide; the sulphur with the potassium; and the nitrogen is set free.

The *chlorate*, $KO+ClO_5$, is remarkable for its deflagrating properties; it yields a large quantity of oxygen gas, on being heated.

Silicate of Potassa.—$KO+SIO_3$.—Silicic acid unites in different proportions with the alkalies. If the base be an excess, a soluble salt is formed, called *liquor silicum;* if the acid be in excess, an insoluble salt (*glass*) is the result. Glass owes its colour to the different metals:—*green*, to the oxide of iron; *blue*, to cobalt; *ruby*, to red oxide of copper; *purple*, to the purple of Cassius; *amethyst*, to manganese, &c.

Sulphur, chlorine, iodine, and bromine, also form compounds with potassium.

Chloride of Potassium, KCl, is obtained in making chlorate of potassa, by passing chlorine gas through a solution of potassa. It much resembles chloride of sodium.

Iodide of Potassium, KI, is made by dissolving iodine in a strong

solution of caustic potash; also by adding iodide of iron to carbonate of potassa in solution; carbonate of iron is precipitated.

Test for the salts of potassa.—1. Tartaric acid in excess gives the sparingly soluble bitartrate (cream of tartar). 2. A solution of chloride of platinum causes a yellow precipitate. 3. The alcoholic solution of carbazotic acid precipitates the yellow carbazotate of potassa. 4. The salts of potash usually colour the flame of the blowpipe purple or violet.

SODIUM.

Its history and mode of preparation are the same as those of potassium.

Prop.—A white metal; resembles potassium in most respects; sp. gr. ·972; decomposes water with great violence, but does not inflame on account of its rapid motion; if this be restrained by means of gum or sugar, it takes fire and is converted into *soda.* Eq=23·3; Symb. (Natrium), Na. It forms two compounds with oxygen, the *protoxide* (soda), NaO, and the *peroxide,* NaO_3; these are formed like, and correspond with, the analogous compounds of potassium.

Hydrate of soda, $NaO+HO$,—prepared from the carbonate by the action of quicklime. Very similar in its properties to the hydrate of potassa.

Carbonate of soda, $NaO+CO_2+10HO$. Prepared by lixiviating the ashes of marine plants, and evaporating; this is known under the commercial names of *barilla,* and *kelp,* which contain many impurities. A purer variety is made by heating together sulphate of soda, lime, and sawdust in a reverberatory furnace. Sulphuret of calcium, sulphurous acid, and carbonate of soda, are formed. This salt is in large rhombic crystals, very soluble in water, of a caustic alkaline taste, and alkaline reaction.

Bicarbonate, $NaO+2CO_2+HO$,—formed as the bicarbonate of potassa. It is less soluble than the carbonate.

Sesquicarbonate, $2NaO_3+3CO_2+4HO$.—Occurs native.

Sulphate of Soda — Glauber's salt, $NaO+SO_3+10HO$; the residue left in the process for making hydrochloric acid. A very soluble salt; more so at 90° than at 212°.—There is also a *bisulphate.*

The *nitrate of soda* is very similar in properties to the nitrate of potash.—The three *phosphates* are spoken of under the head of Phosphorus.

Chloride of Sodium—Common Salt, NaCl,—is found in sea-water and saline springs; it occurs also as a mineral, under the name of rock salt; procured by evaporation from its solution. The crystals decrepitate when thrown on hot coals; they are very soluble in water, and are slightly deliquescent.—Iodine, bromine, sulphur, and fluorine, also combine with sodium.

Test for soda, and its salts. — All the soda salts are soluble; they communicate a yellow colour to the blowpipe flame. Soda forms with sulphuric acid, the well-known Glauber's salt. Soda is less soluble than potassa.

LITHIUM.

Prop.—A white metal resembling sodium;—procured by electrical action from *lithia*, its protoxide, which is found in petalite, and some few other rare minerals. The *hydrate of lithia* generally resembles the hydrates of soda and potassa, but is less soluble.

Test. — It communicates a carmine-red colour to the outer flame of the blowpipe.

AMMONIUM.

Ammonium is the hypothetical metal or radical of ammonia, which has already been treated of under the compounds of Hydrogen and Nitrogen. Its symbol is NH_4; that of ammonia (protoxide), NH_4O, or, NH_3,HO.

Carbonate of Ammonia, NH_4O+CO_2, is made by the union of carbonic acid and ammoniacal gas. The carbonate of the shops is a *sesquicarbonate*, and is made by subliming together carbonate of lime and chloride of ammonium. — There is also a *Sulphate* and a *Nitrate*.

Chloride of Ammonium, or *Sal Ammoniac*, NH_4Cl, is one of the products of preparing coal gas.

For the *tests*, see Ammonia.

SECTION II.

CLASS II.

METALS OF THE ALKALINE EARTHS.

This class includes Barium, Strontium, Calcium, and Magnesium.

BARIUM.

Procured by means of mercury from baryta or its carbonate, through the agency of galvanism, or heat.

Prop. — A grayish-white metal, heavier than water; has a strong affinity for oxygen; malleable.—Symb., Ba. It forms two oxides.

Protoxide, or *Baryta*, BaO. — Occurs in nature as a carbonate and a sulphate; — may be obtained by decomposing the nitrate by heat. It has a strong affinity for water, forming with it a hydrate, with the evolution of heat. The hydrate is a white powder resembling slaked lime; its solution, like lime-water, attracts carbonic acid from the air.

Peroxide of barium, BaO_2, is used in making the peroxide of hydrogen

The salts of baryta are chiefly remarkable for their high specific gravity; the most important are the carbonate, sulphate, and nitrate. The sulphate is very insoluble. The soluble salts are poisonous. Chlorine, iodine, bromine, and sulphur, form compounds with barium.

Test for baryta.—It forms a very insoluble *sulphate.*

STRONTIUM.

Procured as Barium.—Symb., Sr. It forms two oxides.

Protoxide,—Strontia, SrO,—prepared like baryta, which it much resembles. Its other compounds are similar to those of baryta.

Test.—It communicates a blood-red colour to the flame of the blowpipe.

CALCIUM.

A silver-white metal, procured like Barium; — forms with oxygen two compounds. Symb., Ca.

Protoxide, Lime, CaO, — obtained by heating the native carbonates.

Prop.—Lime is white,—infusible,—has a strong affinity for water, forming with it a solid hydrate, with the evolution of much heat; this is seen in the common process of *slaking.* The hydrate is far less soluble in water than those of baryta and strontia; it is more soluble in cold than in hot water; *lime-water* is thus made. Exposed to the air, it attracts carbonic acid, forming a pellicle; hence it is a good test for carbonic acid; it has an alkaline reaction. The hardening of mortar is probably due to the gradual absorption of carbonic acid, or to the combination of the sand and lime, forming a *silicate.*

The most important salts of lime are the sulphate, carbonate, phosphate, and hypochlorite.

Sulphate of lime, or *Gypsum,* $CaO+SO_3$, is found native; the native crystals are called *selenite.*

Prop.—A sparingly soluble salt; forms with water a hydrate;—it is found in most spring water.

Carbonate of lime, Limestone, or *Chalk,* $CaO+CO_2$, is also found native.—The purest varieties constitute *marble.*

Prop.—Insoluble in water, but soluble if carbonic acid be present; exists in many natural waters, as a supercarbonate, and is deposited from them as *stalactites.*

The *phosphate* of lime exists in bones.

Chlorine, iodine, bromine, fluorine, and sulphur form compounds with calcium.

Chloride of calcium is prepared by the action of hydrochloric acid on carbonate of lime. It is distinguished for its great affinity for moisture, and hence is of great use to the chemist in removing water from substances; also used for forming frigorific mixtures. The *fluoride* is found native, as *fluor* or *Derbyshire spar.*

Hypochlorite of lime, commonly called *chloride of lime,* is the well-

known bleaching powder;—prepared by the action of chlorine on thin strata of hydrate of lime.

Test for lime.—Oxalic acid forms an insoluble *oxalate.*

MAGNESIUM.

Obtained by heating the chloride with potassium. It is a white, malleable metal; heated in the air, it is converted into magnesia.

Magnesia is the only oxide, MgO.—Prepared by driving off the carbonic acid from the carbonate, by heat. It is a soft, white, insoluble powder.

Carbonate of Magnesia occurs native; may be easily prepared by double decomposition;—it is very nearly insoluble.

Sulphate of Magnesia, Epsom salts, $MgO+SO_3+7HO$, exists in sea-water, and certain mineral springs; it is very soluble; forms crystals of a right rhombic prism.

Phosphates.—The most interesting is the *ammonio-magnesian phosphate,* or the triple phosphate, $2MgO+NH_4O, PO_5+14HO$. It sometimes constitutes urinary calculi.

Test for Magnesia.—It forms the well-known Epsom salt with sulphuric acid. With phosphate of soda and ammonia it throws down an insoluble ammonio-magnesian phosphate.

SECTION III.

CLASS III.

METALS OF THE EARTHS.

THIS class includes Aluminium, Yttrium, Glucinium, Zirconium, Thorium, Erbium, Terbium, Norium, Cerium, Lantanum, and Didynium.

ALUMINIUM.

Prepared in the same manner as Magnesium. It has a silver-gray colour; of difficult fusibility; forms alumina when burnt in the air.

Alumina is a sesquioxide, Al_2O_3; exists abundantly throughout nature, as a constituent of the different sorts of *clay;*—prepared by adding carbonate of potassa to a solution of alum; the hydrate of alumina is precipitated.

Properties.—It has no taste or smell; feels pasty to the tongue; is very insoluble and infusible; has a strong affinity for water; acts but feebly as a base.

The most important salt of alumina is *alum*—a double sulphate of alumina and potassa, Al_2O_3, $3SO_3+KO$, SO_3+24HO, manufactured

from a native alum ore containing clay and sulphuret of iron. It crystallizes in octohedrons, is soluble in water, and is converted into *dried alum* by being deprived of its water by heat. Either soda or ammonia may be substituted for the potassa, in alum. The salts of alumina are useful as *mordants* in dyeing. Alumina forms the basis of porcelain and earthenware. *Tests for alumina.*—Caustic potash and soda give with it white gelatinous precipitates;—the well-known characteristics of *alum;*—and the blue colour given by nitrate of cobalt by heat.

The remaining metals of the earths are of no particular importance.

SECTION IV.

CLASS IV.

METALS PROPER.

This class may conveniently be subdivided into three orders, viz., 1. Metals whose oxides form powerful bases; 2. Metals whose oxides form weak bases or acids; 3. Metals whose oxides are reduced by heat alone,—noble metals.

ORDER I.—METALS WHOSE OXIDES FORM POWERFUL BASES.

This order includes Iron, Copper, Zinc, Lead, Bismuth, Manganese, Cobalt, Nickel, Cadmium, Uranium, and Cerium.

IRON.

Very rarely occurs native;—exists in *meteorites*, combined with nickel and cobalt. As an oxide, it is widely diffused throughout nature. The most abundant ores of iron, are the oxides, and sulphides, or *pyrites*. Some of the ores are magnetic, and some are not. Iron is extracted from its ores by roasting, and then exposing to a high heat, along with charcoal; by this means the common *cast iron* is procured; this is converted into *soft* or *malleable* iron by exposure to a strong heat, while a current of air plays upon its surface; by this means the carbonaceous matter is burnt off, and the fusibility of the metal is diminished. *Steel* is a carburet of iron, formed by exposing alternate strata of soft iron and charcoal to an intense heat; a direct union ensues, by which the iron acquires greater hardness.

Prop.—Iron has a peculiar gray colour—metallic lustre—not very malleable—quite ductile—the most tenacious of all metals;—it is a hard metal—of a fibrous texture—sp. gr. 9·7—is very infusible—susceptible of the welding process—is attracted by the magnet—may itself

be rendered magnetic by heating—does not oxidize in dry air at common temperatures;—heated to redness, it becomes covered with a scaly coating of the black oxide—burns vividly in oxygen—rusts when exposed to air and moisture—decomposes water at a red heat, evolving pure hydrogen, and giving rise to the black oxide. *Chemically pure iron* may be procured by passing hydrogen gas over the sesqui, or protoxide of iron heated to redness in a porcelain tube. It is sometimes called *pyrophoric iron;*—it is used in medicine. Symb. (Ferrum), Fe.—Eq., 28.—It forms four compounds with oxygen.

Protoxide, FeO,—the base of the native carbonate, and of green vitriol. It can hardly be isolated, from its great proneness to absorb oxygen, and to pass into the state of sesquioxide; the hydrate of the protoxide is formed when an alkali is added to a solution of the protosulphate; it is of a dirty green colour, and speedily becomes red by the absorption of oxygen.

Peroxide (Sesquioxide), Fe_2O_3—occurs in nature under the name of *red hematite;*—made by dissolving iron in nitro-hydrochloric acid, and adding an alkali. *Prop.*—It is not attracted by the magnet;—forms reddish salts with most of the acids. It can easily be detected by the infusion of galls, which gives with it a bluish-black precipitate, the basis of ink,—by ferrocyanide of potassium, which throws down *Prussian blue,*—by sulphocyanide of potassium, which causes a blood-red colour.

Black, or *Magnetic Oxide,* $FeO+Fe_2O_3$,—a mixture of the two former oxides;—occurs native—is one of the most valuable of the ores; it is the product of exposing iron to high heat. It does not form salts.

Ferric Acid, FeO_3,—only recently discovered—obtained by heating together one part of peroxide of iron with four parts of dry nitre, by which the ferrate of potash is formed; it is very difficult to isolate, on account of its extreme susceptibility to decomposition.

Iron forms two compounds with chlorine.

Protochloride, FeCl,—formed by dissolving iron in chlorohydric acid, and drying.

Sesquichloride, Fe_2Cl_3, formed by the combustion of iron wire in chlorine gas.—There are also two *iodides;* the protiodide is used in medicine, and is made by digesting iodine in water, with pure iron wire.

Sulphur unites with iron in several proportions.

Protosulphuret, FeS,—formed by heating iron and sulphur together; it has a blackish colour, and is attracted by the magnet. There is also a *Sesquisulphuret,* Fe_2S_3.

Bisulphuret, FeS_2, *iron pyrites,* exists native; it has a yellow colour and a metallic lustre; it is not magnetic.

Magnetic iron pyrites, is a native ore, consisting of a compound of the protosulphuret and bisulphuret (Stromeyer).

Cyanogen forms certain important double salts with iron.

Ferrocyanide of Potassium, or *Yellow Prussiate of Potash*, $FeCy_3 + 2K$, is made by heating cyanide of potassium with iron; a compound radical—*ferrocyanogen*—is believed to be formed in the process, expressed by $FeCy_3$.

Ferrocyanide of Iron, Prussian Blue, $3FeCy_3+4Fe$, is made by adding ferrocyanide of potassium to a sesquisalt of iron.

Ferrocyanide of Potassium, or *Red Prussiate of Potash*, $Fe_2Cy_6 + 3K$.

Ferrocyanide of Iron, or *Turnbull's Blue*, Fe_2Cy_6+3Fe.—These last two compounds contain a compound radical, *ferrocyanogen*, Fe_2Cy_6.

The most important salts of iron are the sulphates, the carbonate, and the nitrate.

Protosulphate of iron, *green vitriol*, or copperas, $FeO,SO_3,HO+6HO$, is prepared by dissolving iron in dilute sulphuric acid. It is crystalline—of a beautiful green colour—very soluble, and efflorescent. It is isomorphous with sulphate of magnesia. *Sesquisulphate* of iron, —made by the action of nitric acid on a solution of the protosulphate; it has a buff colour, and is sparingly soluble. There is only one carbonate—the *protocarbonate;* this is sometimes found native, and exists in chalybeate springs. There are two *nitrates*.

The best *tests* for iron, are those mentioned under the head of the sesquioxide.

COPPER

Occurs sometimes in native crystals; but, most commonly, as a sulphide, from which the metal is extracted by roasting with charcoal.

Prop.—The only red metal except titanium; has considerable lustre; sp. gr. 8·6; is very ductile, malleable, and tenacious; undergoes but little change in dry air; but, when moist, it is converted into a subcarbonate. Symb. (Cuprum), Cu.—Eq. 31·6. Copper forms two or three oxides.

Dioxide or *red oxide*, Cu_2O, occurs native, in octohedral crystals. It may be formed by heating together the protoxide and copper filings. It forms colourless salts with bases, which, however, are very unstable, from their tendency to absorb oxygen.

Protoxide or *black oxide*, CuO, the basis of most of the salts of copper: — prepared by calcining metallic copper: — by precipitating from any salt by an alkali;—and by heating the nitrate. Its colour varies from a dark brown to a black. There is also a *binoxide*.

There are two *chlorides*, *iodides*, and *sulphides* of copper, similar in composition to the first two oxides.

The most important salts of copper are the *sulphate*, *nitrate*, *carbonates*, and *acetates*. The sulphate—well-known in commerce, as *blue vitriol* — is formed by the action of sulphuric acid on copper. The carbonate occurs native, in the mineral *malacite*. *Verdigris* is com-

posed of one or more of the acetates of copper. The proper solvent of copper is nitric acid.

Tests.—Ammonia, in small quantities, throws down from a solution of the sulphate, the bluish-white hydrated protoxide; but when added in excess, it redissolves the precipitate, forming a deep blue colour. Ferrocyanide of potassium gives a fine reddish-brown ferrocyanide of copper. It is also precipitated upon iron or steel. Copper forms several important alloys, such as *brass*, with zinc; *bell metal*, with tin; and *bronze*, with zinc and lead.

LEAD.

Procured chiefly from the native sulphide or *galena*, by roasting, which converts most of it into a sulphate; the sulphate and sulphuret reacting upon one another, produce sulphurous acid, and metallic lead.

Prop. — A soft, bluish metal; has a metallic lustre when freshly cut; somewhat malleable and ductile, particularly in the form of pipes; not very tenacious: sp. gr. 11·45; melts at 600° F. Exposed to moist air, it becomes coated with a film of the dioxide; also absorbs oxygen when heated in the open air. Symb. (Plumbum), Pb. Eq. 103·6. It forms four oxides.

Dioxide, Pb_2O, formed by heating dry oxalate of lead in a retort; it absorbs oxygen very rapidly.

Protoxide, PbO, the basis of the salts of lead, is prepared by exposing the gray film which collects on the surface of melted lead, and which consists of the protoxide and metallic lead, to a high heat, with the access of air; this constitutes the *massicot* of commerce; when partially fused by heat, it becomes *litharge;* in this state it contains some peroxide. It has a yellow colour, is insoluble in water, unites with acids, forming salts, from which it is precipitated by alkalies as a hydrate, and as *white lead* by alkaline carbonates.

Peroxide, puce, or *brown oxide,* PbO_2, prepared by the action of nitric acid on red lead, which converts it into the protoxide and peroxide. It has a flea-colour, and is insoluble; by heat it is converted into protoxide, and oxygen.

Red lead, or *minium,* Pb_3O_4, or $2PbO+PbO_2$, considered to be a compound of the protoxide and peroxide; is formed by exposing lead to heat in the air, without allowing it to fuse. It is a heavy, brilliant red powder; decomposed, with the evolution of oxygen, by a strong heat; and converted into a mixture of protoxide and peroxide by acids. It is used as a pigment, and in the manufacture of flint-glass.

Chlorine forms with lead a compound known as *plumbum corneum,* or horn lead. Sulphur forms with lead the well-known *galena,* which occurs in cubical crystals. Iodine, bromine, fluorine, and phosphorus also form compounds with lead. The most important salts of lead are the *carbonate* and *acetate;* also the nitrate and sulphate.

Carbonate of lead, White lead, — is sometimes found in a native crystalline state; may be prepared by precipitating from any soluble

salt of lead by means of an alkaline carbonate; — is manufactured by exposing sheet-lead in coils to the action of the vapour of vinegar, at the temperature of decomposing manure: the lead is oxidized by the partial decomposition of the acetic acid, and is then converted into the subacetate. This salt is next decomposed by carbonic acid escaping from the manure in which the lead is packed. It is a soft, white, very heavy powder, insoluble in water; it is much used as a pigment.

Acetate of lead, Sugar of lead, — made by dissolving litharge in acetic acid; occurs in colourless, transparent crystals; has a sweet taste; is very soluble in water, also in alcohol. There are several *subacetates* of lead, made by boiling a solution of the acetate in litharge.

Nitrate of lead, prepared by the action of nitric acid on lead. Nitric acid is the proper solvent of lead;—it is soluble.

Sulphate of lead, prepared by the action of a soluble sulphate on a solution of the acetate of lead; it is a very insoluble salt. Cold sulphuric acid has no action on lead; but when boiling, the lead is slowly oxidized at the expense of the acid. Hydrochloric acid has no action on lead.

Tests.—The alkaline carbonates throw down the insoluble carbonate; the soluble sulphates throw down the insoluble sulphate; sulphuretted hydrogen, or a soluble hydrosulphate, throws down the black sulphide; chromate of potassa gives the yellow chromate of lead; and iodide of potassium yields the yellow iodide of lead.

ZINC

Occurs in nature as a carbonate (*calamine*), or as a sulphide (*zinc blende*). It is procured from the former by heat and charcoal; and from the latter by a similar process, after roasting the ore; at a high temperature, the metal, being volatile, comes over by distillation.

Prop.—A bluish-white metal; has a crystalline texture; sp. gr. 7; brittle at common temperatures; malleable between 250° and 300°; very brittle at 400°; melts at 773°, and at a bright red heat it boils and burns with a brilliant green light, generating the oxide. It is called *spelter* in commerce, and is never quite pure; is slightly tarnished by exposure to the air. Symb. (Zincum), Zn.—Eq. 33.

Oxide of Zinc, ZnO;—prepared by burning zinc in the air, or by heating the carbonate. It is a white, insoluble powder, the basis of the salts of zinc.

Chloride of Zinc, $ZnCl$; — prepared by heating metallic zinc in chlorine, or by dissolving zinc in hydrochloric acid, and drying. It is a white substance, has the consistence of butter, and is hence called *butter of zinc;* very deliquescent, and soluble in water and alcohol.

The important salts of zinc, are the sulphate and the carbonate.

Sulphate of Zinc, white vitriol; — made by acting on zinc with dilute sulphuric acid; the water is decomposed, its oxygen going to

the zinc, and the hydrogen escaping. It is a white, crystalline, soluble salt.

Carbonate of Zinc,—occurs native, and may be formed by double decomposition between any soluble carbonate and the sulphate of zinc.

CADMIUM.

This metal is usually found associated with zinc, in the reduction of which from its ores, the cadmium, being more volatile, flies off.

Prop.—It resembles tin in colour; very malleable; very volatile; sp. gr. 8·7; melts below 500°; when strongly heated, it burns, forming the *oxide*.

BISMUTH

Occurs both native and in combination; it may be procured pure by heating the subnitrate with charcoal.

Prop.—A crystalline metal, of a reddish-white colour and metallic lustre; when slowly cooled, it yields cubical crystals; fuses at 476°, and in close vessels sublimes unchanged; in the open air burns with a bluish flame, and is converted into the *oxide;* its proper solvent is nitric acid. It forms two oxides. Sp. gr. 10.—Eq. 71.

Protoxide, BiO;—the basis of all the salts, has a yellow colour; obtained by heating the subnitrate. *Peroxide*, Bi_2O_3;—Bismuth unites also with chlorine and sulphur.

Nitrate of Bismuth;—made by dissolving the metal in nitric acid, and evaporating. This, when thrown into water, is decomposed into the soluble *supernitrate*, and the insoluble *subnitrate*, which subsides as a white powder.

The best *test* is the formation of the subnitrate; also sulphuretted hydrogen.

MANGANESE

Is found in nature as an *oxide;* procured from this by intensely heating with charcoal.

Prop.—A hard, brittle metal, of a grayish-white colour, very infusible, sp. gr. about 8; forms *seven* compounds with oxygen, viz.: Protoxide, MnO, Sesquioxide, Mn_2O_3, Peroxide, MnO_2, Red oxide, Mn_3O_4, Varvicite, Mn_4O_7, Manganic acid, MnO_3, Permanganic acid, Mn_2O_7. The most important of these, to the chemist, is the peroxide, or black oxide, which occurs abundantly in nature. It is used in the arts, in the manufacture of glass; and by the chemist for procuring chlorine, bromine, and oxygen.

The best *test* for manganese is the play of colours — called the *mineral chameleon*—produced by dissolving manganate of potassa in water. Manganic acid cannot exist uncombined. The changes of colour are owing to the formation of the *permanganate of potassa*, which is red, and the mixture of red and green produces the intermediate colours.

NICKEL AND COBALT.

These two metals strongly resemble each other: both occur in combination with arsenic. Nickel is found associated with meteoric iron, and is strongly magnetic. Cobalt is not so. Both have a white colour. Nickel is malleable; Cobalt is brittle. Nickel is employed in the arts, in the preparation of *German silver*—an alloy of copper, zinc, and nickel.

The best *test* to distinguish cobalt from nickel, is the fine blue colour communicated by the former to the flame of the blowpipe, when fused with borax.

URANIUM AND CERIUM.

These are very rare metals, and are of no practical use.

SECTION V.

ORDER II.—METALS WHOSE OXIDES FORM WEAK BASES, OR ACIDS.

THIS order includes Tin, Antimony, Arsenic, Chromium, Vanadium, Tungsten, Molybdenum, Columbium, Titanium, Tellurium, and Osmium.

TIN

Is found in nature as an *oxide*, from which it may be procured by heating with charcoal. The varieties known in commerce are *block* and *grain tin*.

Prop.—Has a white colour, silvery lustre, is very slowly tarnished by exposure to the air; very malleable, quite ductile, soft, and inelastic, and produces a crackling noise when bent backwards and forwards; sp. gr. about 7; fuses at 442°; heated to whiteness, it burns, and is converted into the peroxide. Symb. (Stannum), Sn.—Eq. 58. It forms three oxides.

Protoxide, SnO;—formed by adding an alkaline carbonate to a solution of the protochloride; a white hydrated protoxide falls.

Sesquioxide, Sn_2O_3,—has a grayish colour.

Peroxide, SnO_2;—prepared either by precipitating by an alkali from a solution of the perchloride, or by the action of nitric acid on metallic tin. Very strong nitric acid has no effect on tin; but, if diluted, violent effervescence ensues from the escape of nitrous acid and binoxide of nitrogen, and the hydrated peroxide is produced; ammonia is also generated at the same time, the hydrogen being furnished by the water.

Protochloride, $SnCl$,—made by dissolving tin in hot hydrochloric acid; occurs in crystals. It is much used as a deoxidizing agent.

Perchloride, $SnCl_2$, called the *fuming liquor of Libavius*;—made

by heating the protochloride, or metallic tin, in chlorine; it is a very volatile, colourless liquid, emitting dense white fumes on being exposed to the air; it is used as a *mordant* in dyeing.

There are three sulphurets of tin—the *protosulphuret*, *sesquisulphuret*, and *bisulphuret;* the latter is sometimes termed *mosaic gold.*

Test.—Solution of chloride of gold throws down, with the protochloride of tin, the *purple of Cassius.*

ANTIMONY

Occurs in nature generally as a *sulphide*, which, in commerce, is called *crude antimony*, while the pure metal is named *regulus of antimony.* It may be obtained from the sulphide by heating it with iron filings.

Prop.—A bluish-white colour—crystalline structure—brittle—sp. gr. 6·8;—at a high temperature it burns in the open air, the vapour condensing in white crystals of the teroxide (*argentine flowers of antimony*); it is acted upon by both nitric and hydrochloric acids. Symb. (Stibium), Sb.—Eq., 129. It forms three compounds with oxygen.

Teroxide, SbO_3,—prepared by burning antimony in the open air,—by precipitation from a solution of tartar emetic by means of an alkaline carbonate, or by the action of carbonate of potassa or soda on the terchloride, when put into water. It is a pale yellow powder—volatile—liable to absorb oxygen. It is the basis of all the antimonial salts.

Antimonious acid, SbO_4,—made by heating the oxide in open vessels;—a grayish-white powder—insoluble—combines with alkalies.

Antimonic acid, SbO_5,—made by action of strong nitric acid on antimony; an insoluble straw-coloured powder; unites with alkalies, to form *antimoniates.*

Terchloride, $SbCl_2$ (*butter of antimony*),—made by burning antimony in chlorine gas; a soft solid at common temperatures; when put into water, hydrochloric acid and the sesquioxide are generated, and the latter, combined with some undecomposed chloride, subsides as the *powder of Algaroth.* There are one or two other chlorides.—There are several *sulphides*, of which the most important is the native *tersulphide;* it is a lead-gray substance, brittle, and fusible. It may be made by melting sulphur and antimony together, or by passing sulphuretted hydrogen through a solution of tartar emetic. There are also a *pentasulphide* and a *pentachloride.*

Kermes mineral.—Prepared by boiling tersulphuret of antimony in a solution of caustic potassa; a partial double decomposition ensues, by which an oxide of antimony, and a sulphuret of potassium are formed; the latter unites with undecomposed sulphide of antimony to form a sulphur-salt, in which the sulphide of antimony is the acid, and sulphide of potassium the base. As the solution cools, this double salt becomes decomposed, the tersulphide of antimony subsiding along with a variable portion of potassa and oxide of antimony. This is the

kermes, which may hence be considered as an *oxy-sulphide*. The mother waters still contain some of the above sulphur-salt, together with potassa and oxide of antimony; and, on the addition of sulphuric acid, the teroxide and tersulphide are precipitated together, but without the potassa; this is the *golden sulphuret*.

The most important salt of antimony is *tartar emetic*;—made by boiling cream of tartar with the teroxide of antimony. It is a white, crystalline, soluble salt, which gives a brick-red precipitate (the tersulphuret) with sulphuretted hydrogen; it also yields precipitates with the alkalies, earths, tannic acid, &c. It is a neutral bibasic salt—tartrate of antimony and potassa—the oxide of antimony merely substituting the water in the cream of tartar (tartrate of potassa and water).

ARSENIC

Is sometimes found native, but is generally procured from the native arseniuret of cobalt and nickel, by means of heat.

Prop.—A steel-gray colour; metallic lustre; very brittle; tarnishes in the air; sp. gr. 5·9; volatilizes by heat, and, if air be present, is converted into arsenious acid; its vapour has the odour of garlic. Symb., As.—Eq., 76·4. It forms two well-known compounds with oxygen, *arsenious*, and *arsenic* acids; but no basic compound.

Arsenious acid, white oxide of arsenic, fly powder, AsO_3, — is always generated when arsenic is heated in the open air; that of commerce is derived by roasting the native ores of cobalt. It is quite transparent and glassy when first prepared, but becomes opaque by exposure; volatile at 380°; vapour is inodorous, and condenses on cool surfaces; not very soluble in water; reddens vegetable blues feebly; combines with bases, forming *arsenites;* it has an acid taste, and is very poisonous.

Arsenic acid, AsO_5,—made by dissolving arsenious acid in strong nitric acid, mixed with a little hydrochloric acid, and evaporating to dryness. It is sour to the taste; much more soluble in water than arsenious acid; forms *arseniates;* is isomorphous with phosphoric acid; when strongly heated, it is converted into arsenious acid and oxygen.

There are three well-known sulphides of arsenic.

Bisulphides or *Realgar*, AsS_2, occurs native;—may be made by heating together sulphur and arsenious acid; colour, ruby-red.

Tersulphide or *Orpiment*, AsS_3, is also found native;—made by transmitting sulphuretted hydrogen through a solution of arsenious acid: colour, yellow,—called *king's yellow*.

Pentasulphide, AsS_5, made by action of sulphuretted hydrogen on a solution of arsenic acid; it resembles orpiment in colour. The sulphides are poisonous.

Arsenic also unites with chlorine, iodine, &c.

Arseniuretted hydrogen, AsH_3, prepared by adding arsenious acid to the materials for generating hydrogen; colourless; odour of garlic;

sp. gr. 2·6; burns with a blue flame, generating arsenious acid; a non-supporter of combustion; very poisonous when breathed; slightly soluble in water.

Tests for arsenic.—1. Ammoniacal nitrate of silver (made by adding ammonia to a solution of nitrate of silver, until the oxide of silver, which is thrown down, is nearly all dissolved); arsenious acid added to this, throws down the insoluble arsenite of silver of a yellow colour.

2. *Ammoniacal sulphate of copper* (made by adding ammonia to a solution of sulphate of copper), throws down, with arsenious acid, the insoluble arsenite of copper (*Scheele's green*).

3. *Hydrosulphuric acid*, when transmitted through a solution of arsenious acid, precipitates the tersulphide (orpiment).

4. The production of *arseniuretted hydrogen.* — By adding the matter containing arsenic to the materials for generating hydrogen, on burning a jet of this gas, and holding over it a piece of glass or porcelain, an *arsenical ring* is formed.—None of the above tests can be relied on singly. The best method is to *reduce* the arsenic by means of heat and charcoal (or black flux), in a glass tube; by which means the arsenical ring may always be produced, and the peculiar odour of burning arsenic be detected. The proper antidote for arsenic is the *hydrated peroxide of iron*, in a moist state.

The remaining metals of this order are Chromium, Vanadium, Tungsten, Molybdenum, Columbium, Titanium, Tellurium, and Osmium. None of them are of practical importance except *chromium*, two salts of which are much used in the arts, viz.: *chromate of lead* (chrome yellow), and the *bichromate of potash.* Chromic acid is remarkable for the facility with which it parts with oxygen; it is, therefore, much used in organic analysis.

SECTION VI.

ORDER III.—METALS WHOSE OXIDES ARE REDUCED BY HEAT.

GOLD

Occurs either pure, in union with quartz, or combined with silver or copper. It is usually separated from impurities by amalgamation with mercury, which is afterwards driven off by heat. From silver it is separated by the process of *quartation*, which consists in adding to the alloy so much silver as to make the latter constitute three-fourths of the mass; in which case the whole of the silver may be

removed by nitric acid. May be obtained pure by dissolving in nitro-muriatic acid, and then precipitating by a protosalt of iron.

Prop.—It has a well-known yellow colour; is the most malleable, and one of the most ductile of all metals; is not tarnished by either air or moisture; sp. gr. 19·3. Symb. (Aurum), Au. The only solvent for gold is a mixture of nitric and hydrochloric acids, or rather, the solution of chlorine which thence results. An etherial solution of gold is made by agitating ether with the strong aqueous solution; this may be used for gilding. If *protochloride of tin* be added to the solution of gold, the *purple powder of Cassius* is thrown down. Gold forms compounds with oxygen, chlorine, iodine, and sulphur. Gold coins are always alloyed with copper or silver, which increase its hardness. The best *test* for gold is the protochloride of tin.

SILVER

Occurs native, and in combination with gold, and other metals; also with chlorine, and sulphur. One of the most abundant silver ores is the *argentiferous galena*. It is extracted either by amalgamation, or by *cupellation*,—the latter process being only applicable to the combinations with lead. Pure silver may be procured by precipitation from a solution in nitric acid, by means of chloride of sodium, and heating the resulting chloride with carbonate of soda.

Prop. — The whitest of all metals; has a brilliant lustre; is very malleable and ductile; the best conductor of heat and electricity; sp. gr. 10·5; is not acted upon by moisture or air, unless sulphur be present; its proper solvent is nitric acid; Symb., Ag. It forms two or three oxides, of which the protoxide acts as a base. The most important salt is the *nitrate*, or *lunar caustic*, — made by dissolving silver in nitric acid, and evaporating. The crystals are colourless; very soluble in water; the solution becomes dark-coloured when exposed to light, in contact with organic matter, probably from the formation of an oxide.

The *arbor Dianæ* is made by suspending mercury in a solution of the nitrate: the silver is precipitated in the form of crystals. It is also precipitated by the chlorides, phosphates, chromates, arseniates, arsenites, and several of the metals.

The best *test* is chlorine, or a soluble chloride, which precipitates the white chloride of silver.

Silver forms compounds with chlorine, iodine, and sulphur.

PLATINUM

Occurs only in the metallic state, generally combined with other metals, particularly palladium, osmium, rhodium, and iridium. It is found in grains, which are converted into masses by intense heat and pressure.

Prop.—It has a whitish colour; very malleable; the most ductile of metals; the heaviest body in nature; sp. gr. 21·5; is soft; can be

welded, like iron; undergoes no change by exposure to air, moisture, or the highest heat of a smith's forge; it can only be fused by galvanism or the oxy-hydrogen blowpipe; it is dissolved by nitromuriatic acid. In its habitudes with oxygen, chlorine, and sulphur, it resembles gold.

Spongy platinum has the singular property of causing the union of oxygen and hydrogen gases, producing combustion. This is probably due to the intimate molecular relationship into which the two gases are brought in the pores of the metal.

Tests. — A solution of chloride of potassium produces with chloride of platinum a double chloride, of a pale yellow colour; sal ammoniac gives with it a yellow precipitate, which, by heat, yields spongy platinum.

The other metals associated with platinum (Palladium, Osmium, Iridium, and Rhodium), need no particular description.

MERCURY OR QUICKSILVER

Occurs in the metallic state; but more frequently as a sulphide or chloride;—extracted by heat, which sublimes the mercury.

Prop.—The only metal fluid at ordinary temperatures;—has a silver white colour, and brilliant lustre; becomes solid at —39°, when it is malleable; boils at 662°; sp. gr. 13·6; that of frozen mercury, about 14. Pure mercury is not altered by the air at common temperatures, but absorbs oxygen when heated. Hydrochloric acid has no action, nor sulphuric acid, unless concentrated and boiling; nitric acid, even when cold and dilute, acts upon it, forming a nitrate.

Mercury forms two oxides, the *black* and the *red.* The eq. is 202 (Turner, Hare), or 101 (Graham, Kane, &c.). The nomenclature of the different compounds will, of course, depend upon the adoption of either one of these.

Protoxide, HgO (suboxide, Hg_2O).— Prepared by action of caustic potash, or lime, on a solution of the nitrate, or on calomel; it is a dull gray powder, insoluble in water;—decomposed, by the action of light, into the red oxide, and metallic mercury.

Peroxide, HgO_2 (protoxide, HgO), *red oxide.* — Prepared by the combined agency of heat and air; by heating the nitrate; or by precipitation from a solution of corrosive sublimate, by means of potassa. It is often called *red precipitate.* It is in the form of fine red shining scales, very slightly soluble in water; converted by heat into metallic mercury, and oxygen.

Chlorine forms two compounds, *calomel* and *corrosive sublimate.*

Protochloride, or calomel, $HgCl$ (subchloride, Hg_2Cl). Prepared either by *precipitation,* by means of chloride of sodium in a solution of the nitrate; or by subliming together the protosulphate of mercury and chloride of sodium. The rationale is as follows :—

Protosulphate of mercury.	Mercury	Calomel, HgCl.
	Oxygen	
	Sul. acid	
Chloride of sodium	Chlorine	
	Sodium	Sulphate of soda.

As prepared by ordinary sublimation, calomel occurs in yellowish-white masses; but if the vapour be conducted into a recipient containing watery vapour, it is condensed in a very fine white powder. It is insoluble, tasteless; sp. gr. 7·2; is apt to contain a little corrosive sublimate, which can be removed by washing, or throwing down by ammonia. Potassa or lime decomposes it, throwing down the black oxide.

Bichloride, or *corrosive sublimate*, $HgCl_2$ (protochloride, HgCl.)—Prepared by burning mercury in chlorine gas; by action of hydrochloric acid on the red oxide; or preferably, by subliming together the bisulphate with common salt, thus :—

1 eq. bipersulphate of mercury	Mercury	Bichloride of mercury, $HgCl_2$
	2 Oxygen	
	2 Sul'c acid	
2 eq. chloride of sodium.	2 Chlorine	
	2 Sodium	2 eq. sulphate of soda.

Prop.—Crystalline; soluble in water, alcohol, and ether. The alkalies and their carbonates throw down from it the red oxide; ammonia in excess throws down from its solution the *white precipitate*, which is considered to be an *amo-chloride* of mercury (Kane). This amo-chloride, or *chloramide*, as it is often called, is considered to be a double salt, composed of the *biamide* of mercury and some undecomposed *bichloride*.—*Albumen* is the best antidote for it.

There are two iodides, two bromides, one cyanide, and two sulphides of mercury. The bisulphide occurs native, under the name of *cinnabar;* its powder is called *vermilion*. *Ethiop's mineral* is made by triturating mercury and sulphur together, until the globules disappear; it is considered to be a mixture of sulphur and the bisulphide.

The most important *salts* are formed with nitric and sulphuric acids, each of which unites with the protoxide and the peroxide. The *turpeth mineral* is the subsulphate, formed by throwing the sulphate into water.

The best *tests* for mercury are: iodide of potassium, which gives with a protosalt the *green* iodide, and with a persalt, the beautiful *red* biniodide;—protochloride of tin gives a black precipitate if heated with a protosalt;—a drop of mercurial solution put upon a polished surface of gold, and touched with the point of a penknife, instantly causes a white stain, from the amalgam which is formed by the galvanic agency.

PART III.

ORGANIC CHEMISTRY.

GENERAL OBSERVATIONS.

ORGANIC substances, whether derived from the vegetable or animal kingdom, are chiefly remarkable for the complexity of their composition, and for the limited number of their elements. Only *four* elements are considered essential to the composition of organic matter, viz., carbon, oxygen, hydrogen, and nitrogen, — though others are occasionally met with, as sulphur, phosphorus, chlorine, sodium, &c.; altogether they do not amount to more than fifteen. There appears, however, to be no limit to the number of definite compounds which may be produced out of merely the four above-named essential elements, simply by a difference in their proportions and mode of arrangement.

In consequence of the complexity of organic bodies, they are generally very instable, being prone to decomposition whenever the restraining force is removed. The products of such decomposition are water, carbonic acid, and ammonia; and if sulphur be present, sulphuretted hydrogen.

As a general rule, the more complex is the constitution of an organic body, the more liable is it to decomposition; but this tendency is much lessened if the elements are in such proportions as completely to *saturate* each other; thus, in sugar, starch, and lignin, the proportions of oxygen and hydrogen are exactly sufficient to saturate each other, and to form water.

Vegetable organic matter is usually *ternary* in its composition, and is not so prone to decomposition as animal organic matter, which is generally *quartenary*. Both are invariably decomposed by heat.

Isomeric bodies are frequently met with among organic substances. By this term is meant bodies having the same chemical composition, but possessing very different properties; starch, sugar, and gum are examples. Isomerism is believed to depend upon a *different arrangement* in the constituent atoms of a body, — their number remaining the same.

SECTION I.

OF COMPOUND RADICALS.

BY the term *compound radical*, is meant a substance which, although containing two or more elements, acts precisely as a simple

elementary body. The following are the most important of the admitted compound organic radicals, together with their chemical composition expressed in symbols.

	Formula.
Carbonic oxide, or protoxide of carbon	CO.
Cyanogen, or bicarburet of nitrogen	C^2N.
Mellon, or sesquicarburet of nitrogen	C^6N^4.
Benzoile, benzule, or benzyle	$C^{14}H^5O^2$.
Cinnamyl, or cinnamule	$C^{18}H^8O^2$.
Salycyle, or salicule	$C^{14}H^5O^4$.
Acetyle, or acetule	C^4H^3.
Formyle, or formule	C^2H.
Amide	NH^2.
Ethyle, or ethule	C^4H^5.
Methyle, or methule	C^2H^3.
Cetyle, or cetule	$C^{32}H^{33}$.
Glyceryle, or glycerule	C^6H^7.
Amyle, or amule	$C^{10}H^{11}$.
Mesetyle, or mesetule	C^6H^4.
Kacodyle, or kacodule	C^4H^6As.

Besides these, there are some subordinate compound radicals. A few of the above radicals will be noticed now; the others will be spoken of when their compounds come under consideration.

Amide, NH_2, or amidogen. This compound radical is believed to be generated when ammonia is heated in contact with potassium or sodium; hydrogen is liberated, and a compound formed of amyde and the metal. When the amyde of potassium or sodium thus generated is put into water, this liquid forms ammonia by yielding up hydrogen to the amyde; and at the same time it converts the potassium into potash, by giving up its oxygen. According to this view, ammonia is an amyde of hydrogen. Ammoniated mercury (white precipitate) is a compound of an amyde and the bichloride of mercury.

Carbonic oxide, CO, has already been spoken of as a compound of carbon. By combining with carbonic acid, CO_2, it constitutes *oxalic* acid, C_2O_3. The most important compounds of this radical are *carbamide*, *oxamide*, and *chloroxycarbonic* acid, a compound of carbonic oxide and chlorine.

Benzule or *Benzyle*, $C_{14}H_5O_2$,—the hypothetical radical of benzoic acid, and of the oil of bitter almonds. By the addition of an atom of oxygen and an atom of water, it forms benzoic acid. By substituting an atom of hydrogen for an atom of oxygen, benzoic acid is converted into the oil of bitter almonds, or the *hydruret of benzule.* This hydruret does not pre-exist in the bitter almonds, but is the result of the reaction of two organic principles contained therein, denominated amygdalin and emulsin, or synaptase, with water.

Benzule forms a compound with amide called *benzamide.*

Cinnamyle, $C_{18}H_8O_2$, has much analogy with benzule. It is the radical of the *oil* of *cinnamon*, and of a few other compounds.

Glyceryle, C_6H_7, the compound radical of *glycerine*, the hydrated

oxide of glyceryle, which is the base common to many oils and fats. Glycerine will be more fully spoken of under the head of Oils.

Cetyle, $C_{32}H_{33}$, an organic radical, which performs precisely the same part in spermaceti that glyceryle does in ordinary fats.

SECTION II.

ANALYSIS OF ORGANIC BODIES.

As all organic bodies undergo decomposition when exposed to a high temperature, in the presence of oxygen, this is the method adopted to effect their analysis; it is founded on the fact that the weight of the carbonic acid and water, resulting from the union of oxygen with the carbon and hydrogen of the organic body, will indicate the relative proportions of the latter elements. The following is an outline of Liebig's method, which is by far the most simple:—A tube of white Bohemian glass, called a *combustion-tube*, about a foot long, is drawn out at one extremity to a point, which is closed; the organic substance is mixed with the black oxide of copper (a substance which readily imparts oxygen when heated with an organic body), and the mass, being thoroughly dried and accurately weighed, is introduced into the tube. To this is attached another tube, containing dried chloride of calcium, to absorb the water that may form; this is also weighed. Lastly, to the end of the latter tube is attached an arrangement of glass bulbs containing solution of potassa, intended to absorb the carbonic acid that may be formed; this is likewise weighed.

Heat is now applied to the combustion-tube; decomposition of the organic body ensues; its carbon takes oxygen from the oxide of copper to form carbonic acid, every twenty-two grains of which contains six of carbon. The hydrogen of the organic body also takes oxygen to form water, every nine grains of which must contain one of hydrogen.

The result is then easily estimated, by a second weighing of the chloride of calcium tube, and the potash bulbs; the gain of the former indicating the amount of water, and *one-ninth of this gain expresses the quantity of hydrogen;*—the gain of the latter indicating the amount of carbonic acid, and six parts in twenty-two, or *three-elevenths of this, expresses the quantity of carbon.* Having thus ascertained the weight of carbon and of hydrogen, their sum, subtracted from the whole weight of the organic body, will give the weight of its oxygen.

If the body to be analyzed contains *nitrogen*, an alkali must be added to convert the nitrogen into ammonia, which is afterwards converted into chloride of ammonium by hydrochloric acid, next precipitated by bichloride of platinum, and then heated to drive off the chlorine and

ammonium. The loss of weight gives the data for calculating the amount of nitrogen.

If *sulphur* is present, it is to be converted into sulphurous acid, and then oxidized by nitric acid; the sulphuric acid is neutralized by baryta, and from this, the amount of sulphur can be calculated.

In organic analysis, the utmost precision is required in the processes of drying and weighing.

SECTION III.

VEGETABLE NON-AZOTIZED SUBSTANCES.

THESE embrace *Gum*, *Sugar*, *Fecula* or *Starch*, and *Lignin;* and, according to Prout, they may be considered as *hydrates of carbon*, since they contain hydrogen and oxygen in the proportions to form water.

GUM.

This is a proximate principle, which spontaneously exudes from various trees. It is distinguished from resin by being soluble in water, and being insoluble in alcohol, and by the action of nitric acid, which converts it into *mucic acid*.

Guerin divides the gums into three classes:—1. *Arabin*, of which gum arabic is the type, soluble in cold water. 2. *Bassorin*, of which tragacanth is the type, which swells into a jelly, but does not dissolve in water. 3. *Cerasin*, from the gum of the cherry-tree; insoluble in cold, but soluble in hot water, by which it is partially converted into arabin.

The *mucilage* of gum arabic differs somewhat from the mucilage of flaxseed: the former is precipitated by the *subacetate* of lead; the latter by the neutral *acetate*.

Pectine, or the jelly of fruits, seems closely allied to the gums. It forms *pectic acid*.

SUGAR.

This is found in various saccharine natural juices, as of the Sugar Cane, the Maple, the Beet, &c. There are several varieties of sugar.

Cane sugar, $C_{24}H_{22}O_{22}$, prepared from the juice of the sugar-cane by boiling and evaporating; this constitutes *common brown sugar;* it is refined by dissolving in water, and removing the impurities by means of coagulating albumen. The uncrystallizable portion is named *molasses*. It is converted into grape-sugar by acids and a ferment.

Grape sugar, $C_{24}H_{28}O_{28}$, exists in many vegetable juices, especially in grapes. Examples of it are seen in candied sweetmeats, and in raisins; it also occurs in the urine, in diabetes. Grape sugar differs

from cane sugar in several particulars: it is less sweet, less soluble, and does not form such regular crystals. Strong mineral acids have but little effect on grape sugar; the alkalies, on the contrary, produce a decided effect. It is the only sugar capable of undergoing the vinous fermentation; the others being first converted into it.

The best *test* for grape sugar (as in diabetic urine) is to heat it with a little potassa and protosulphate of copper; a characteristic reddish precipitate occurs, consisting of the suboxide of copper.

Sugar of milk, Lactine, $C_{24}O_{24}H_{24}$; — this is the sweet principle of milk: it is procured by evaporating whey. It undergoes fermentation, like other sugars, but is believed to be converted into grape sugar in the process.

Mannite or *Manna sugar*, $C_6H_7O_6$;—this differs from other sugars in not undergoing the vinous fermentation. There is also a sugar from *mushrooms*, and one from *liquorice*.

FECULA, OR STARCH.

A very abundant proximate vegetable principle, abounding in roots, stems, and seeds. It is procured from flour or potatoes by the action of a stream of water upon them so as to wash off the insoluble particles of fecula.

Prop.—Insoluble in cold water, alcohol, or ether; appears to be a homogeneous substance, but if examined by the microscope, it is found to consist of granules, having a thin, insoluble envelope; when starch is put into hot water, the envelope bursts, liberating the contents, which form with the water a gelatinous mass. The most delicate *test* for starch is iodine, which forms with it a blue colour.

The size of the granules of fecula, as shown by the microscope, varies very much, according to the source from which it is derived. Arrow-root, sago, and tapioca, are examples of pure fecula.

In the process of the germination of seeds, and of the fermentation of malt, the starchy matter of the grain is converted into a sweetish, gummy matter, called *dextrine*, and ultimately into grape sugar. The cause of this remarkable change is due to a peculiar principle found resident in the grain at that period, named *diastase*, which acts by *catalysis*,—itself undergoing no change.

Dextrine has the same composition as starch. It is soluble in water. It is used in the arts as a substitute for gum. Dilute sulphuric acid also has the power of converting starch into sugar. Nitric acid converts it into oxalic acid.

LIGNIN, OR CELLULOSE.

This constitutes the basis of vegetables and of wood. It is procured from sawdust by dissolving it successively in water, alcohol, ether, dilute acid, and an alkaline solution. It has no taste, but may be converted into dextrine and grape sugar by the action of strong sulphuric acid. In its composition it is isomeric with starch.

SECTION IV.

PRODUCTS ARISING FROM CHEMICAL REACTIONS IN THE PRECEDING SUBSTANCES.

ACTION OF NITRIC ACID.

Oxalic Acid, C_2O_3, or $CO+CO_2$, is always formed by the action of strong nitric acid on any of the preceding bodies, except gum and sugar of milk. The oxygen of the acid acting upon the sugar, &c., converts it into oxalic acid, producing, at the same time, nitric oxide and water. It occurs in crystals, much resembling Epsom salts; of an intensely sour taste; soluble in water and alcohol; very poisonous. *Test,*—lime forms the insoluble oxalate of lime.

Pyroxylin, or *gun-cotton,* $C_{12}H_9O_9+2NO_5+HO$; prepared by the action of *strong* nitric acid on pure lignin, or cotton; the latter, apparently, undergoes no change, but becomes very explosive. Dissolved in ether, it constitutes *collodeon,* so much valued for its adhesive properties.

Xyloidine, $C_6H_4O_4+NO_5$, —made by the action of nitric acid on paper. It resembles the preceding.

VINOUS FERMENTATION AND ITS PRODUCTS.

When a solution of sugar, in connexion with some ferment, as yeast, is subjected to a temperature of 70° to 80°, an intestine movement commences, denominated *fermentation;* bubbles of gas escape, the liquor becomes turbid; after a while, it becomes clear, when sugar is found to have disappeared, and its place is occupied by alcohol. Such a liquid will yield *alcohol* by distillation. The gas which is generated and escapes is carbonic acid. The chemical change which is produced is the conversion of one atom of anhydrous grape sugar into two atoms of alcohol, and four atoms of carbonic acid.

Two atoms of alcohol	$C^8H^{12}O^4$
With four atoms of carbonic acid	$C^4\ \ O^8$
Form one atom of sugar	$C^{12}H^{12}O^{12}$

In the process of fermentation, the yeast, or ferment itself, undergoes change, in which respect the action differs from that of *catalysis.*

The various kinds of fermented liquors, such as *wine, cider, beer,* &c., are made from the juices of different fruits, or from infusions of grain. These all contain sugar and a fermenting principle, and hence will undergo the vinous fermentation, provided they be exposed to a proper temperature. The amount of alcohol contained in the fermented liquors varies from 3 to 20 per cent. By distilling any of the fermented liquors, the different *spirituous* liquors, or *ardent spirits,* are procured; these contain about fifty per cent. of alcohol; and by

a second distillation, they yield the commercial alcohol, or *rectified spirit*, which has a density of ·835, and which yet contains about 14 per cent. of water.

Pure or *absolute* alcohol cannot be obtained by any number of distillations, unless quicklime, chloride of calcium, or sulphuric acid, be employed at the same time, to combine with the water.

Pure alcohol is colourless and limpid; has a sp. gr. of ·793; is inflammable, burning with a pale bluish flame, and yielding water and carbonic acid; boiling point, 173°; unites with water in all proportions; also with ether; has powerful solvent powers; it has never been frozen by the most intense cold.

The process of making bread is an instance of the vinous fermentation, the yeast added to the dough, converting a small portion of its sugar into carbonic acid and alcohol. The gas thus liberated, forces the tough and adhesive mass into bubbles; these still further expand by the heat of the oven, which at the same time dissipates the alcohol.

ACTION OF ACIDS ON ALCOHOL—ETHERIFICATION.

When alcohol is heated with any of the strong acids, an *ether* results. The radical *ethyle*, C_4H_5, is the basis of all the alcohol series of ethers. This radical has lately been isolated. Common ether is an *oxide of ethyle*, C_4H_5O; and alcohol is a *hydrated oxide of ethyle*, C_4H_5O+HO. Consequently, the conversion of alcohol into ether only requires the removal of an atom of water. The rationale, then, of the action of sulphuric acid on alcohol is merely to remove the water upon which the alcohol depended for its existence. There is hardly any acid from which a pecular ether bearing its name has not been formed, such as *nitric ether*, *acetic ether*, *tartaric ether*, &c.

The oxide of ethyle, in consequence of being procured by the action of sulphuric acid on alcohol, was formerly called *sulphuric ether*, the name which it continues to bear in commerce; it is also frequently known by the simple name *ether*.

Prepared, by boiling together equal weights of alcohol and sulphuric acid, and receiving the products in a vessel surrounded by ice. Various other substances are generated at the same time, such as sulphovinic acid, oil of wine, sulphurous acid, and others. The ether obtained may be mixed with a little caustic potash, and redistilled by a gentle heat.

Prop. — Pure ether is a colourless, transparent, fragrant liquid; sp. gr. about ·720; boils at 96°; very volatile and inflammable; burns with a white flame, generating water and carbonic acid. Its vapour has a sp. gr. of 2·586. When mixed with oxygen, it explodes with violence, by means of an electric spark. When ether is transmitted through a red-hot tube, it is decomposed into olefiant gas, light carburetted hydrogen and aldehyde. It is very soluble in alcohol; but only one part is dissolved in ten of water. It may be separated from

alcohol by the addition of water, which unites with the alcohol. It is a solvent for oils and fats generally; but its solvent powers are inferior to those of either alcohol or water.

Regarding ether to be a compound of ethyle with oxygen, or an *oxide of ethyle*, it is found that this oxide is capable of uniting with the oxacids, and forming with them compounds analogous to salts. All the halogen bodies, as chlorine, iodine, bromine, &c., unite directly with the radical of ether, just as they do with metallic radicals. The following are some of the ether compounds:—

Ethyle	C^4H^5
Oxide of ethyle, ether	C^4H^5O
Hydrate of the oxide, alcohol	C^4H^5O+HO
Chloride of ethyle	C^4H^5+Cl
Iodide of ethyle	C^4H^5+I
Bromide of ethyle	C^4H^5+Br
Nitrate of oxide of ethyle	$C^4H^5O+NO^5$
Hyponitrite of oxide of ethyle	$C^5H^5O+NO^3$
Oxalate of oxide of ethyle	$C^4H^5O+C^2O^3$, &c.

These compounds of ethyle and its oxide are obtained from alcohol —the hydrated oxide—by the action of the corresponding acids, as on an ordinary metallic oxide.

Hydrate of oxide of ethyle, Alcohol.—This compound can only be obtained through the medium of the vinous fermentation. Its properties have already been described.

Chloride of ethyle, Hydrochloric Ether.—Prepared by the action of chlorohydric acid on alcohol, the product being collected in a cold receiver; or else alcohol may be added to the materials for generating the acid, viz. common salt and sulphuric acid. The rationale is precisely similar to that of the action of hydrochloric acid on a metallic oxide.

Prop.—A colourless, limpid liquid, very volatile, of a penetrating aromatic odour;—sp. gr. ·874; boils at 52°; soluble in ten parts of water.

Bromide of ethyle, Hydrobromic ether;—a very volatile liquid, heavier than water; of a penetrating odour and taste.

Iodide of ethyle, Hydriodic ether;—very closely resembles the last.

Sulphuret of ethyle;—a colourless liquid, of a disagreeable alliacious odour; boils at 163°

Cyanide of ethyle—resembles the last.

Acid Sulphate of oxide of ethyle, Sulphovinic acid, C_4H_5O, $2SO_3+HO$.—Sulphuric acid forms also a *neutral* compound with the oxide of ethyle, lately discovered. Sulphovinic acid is the *acid* sulphate of ethyle. It is formed by the action of strong sulphuric acid on alcohol, as in the preparation of ether; on cooling, it is diluted with water, and neutralized with chalk, which throws down sulphate of lime; the *sulphovinate of lime* is afterwards deposited in crystals: from this, sulphovinic acid may be obtained by the action of dilute sulphuric acid. It is a sour liquid, very apt to be decomposed into

alcohol and sulphuric acid; forms *sulphovinates* with bases, which are soluble.

Phosphate of oxide of ethyle, or *Phosphovinic acid*, is a compound very analogous to the foregoing.

Nitrate of oxide of ethyle, Nitric ether.—This compound has only lately been prepared. It is formed by the action of nitric acid on alcohol, with the addition of urea; the latter substance being requisite to prevent the formation of hyponitrous ether. It has a density of 1·112;—is insoluble in water;—has an agreeable sweet taste.

Hyponitrite of the oxide of ethyle, Hyponitrous ether, Nitrous ether.—This is best prepared, according to Liebig, by the action of hyponitrous acid, derived from nitric acid on starch, on alcohol, and condensing the product. A better method—that of Dr. Hare—is to act upon hyponitrite of soda by sulphuric acid and alcohol; the process being conducted in a refrigerated receiver. It is a pale, yellow liquid, very volatile, possessing an exceedingly agreeable odour and taste; boils at 62°; sp. gr. ·947. It is the active principle of *sweet spirits of nitre*, which consist of hyponitrous ether dissolved in alcohol.

In the same way we have *Carbonic Ether, Oxalic Ether, Acetic Ether, Formic Ether*, &c. &c.

ACTION OF OXYGEN ON ALCOHOL.

When alcohol is oxidized in the open air, that is burned, the products of the combustion are carbonic acid and water. But under peculiar conditions the alcohol may be *dehydrogenized*, i. e., deprived of its hydrogen only, leaving its carbon untouched. From such an action there result certain compounds having one common radical called *Acetyle*, C_4H_3. This differs from ethyle, the radical of ether, in containing two atoms less of hydrogen, and in forming compounds which are acids instead of bases.

The following are some of the acetyle compounds:

Acetyle	C_4H_3
Hydrated oxide (Aldehyde)	$C_4H_3O + HO$
Hydrated binoxide (Aldehydic acid)	$C_4H_3O_2 + HO$
Hydrated tritoxide (Acetic acid)	$C_4H_5O_3 + HO$
Acetone	C_4H_4O
Acetal	$C_8H_9O_3$

Acetyle and its protoxide are alike hypothetical.

Aldehyde, Hydrated oxide of Acetyle, named from *alcohol dehydrogenatus*, is procured from alcohol or ether, by depriving them of two equivalents of hydrogen by means of oxygen. This is effected either by passing the vapour of alcohol through a red-hot tube; by putting a coil of fine platinum wire around the wick of a burning alcohol lamp; and best, by the action of chromic acid, alcohol being distilled with dilute sulphuric acid, and bichromate of potassa; the aldehyde is condensed in a cold receiver, and redistilled with chloride of calcium.

Prop. — A limpid, colourless liquid, having the odour of apples; boils at 72°; sp. gr. ·790. When heated with oxide of silver it causes a deposition of the latter in the metallic form, and is itself converted into aldehydic acid.

Aldehydic or *Acetylous Acid*—the hydrated binoxide of acetyle—is procured as just mentioned.

Acetic, or *Acetylic Acid* — the hydrated tritoxide of acetyle. If alcohol be presented to spongy platinum, the oxygen condensed into the pores of the latter reacts so powerfully upon the former as to cause its inflammation; but if diluted and slowly added, gradual combustion goes on, and acetic acid is evolved. It is also formed by the destructive distillation of wood. Various fermented liquids when exposed to the air become *sour*, that is, their alcohol unites with the oxygen of the air, giving rise to vinegar. The formula for alcohol is C_4H_5O+HO. If to this we add four atoms of oxygen, we have $C_4H_6O_2+4O$, which gives the formula of hydrated acetic acid, = $C_4H_3O_3, HO+2HO$.

The vinegar of commerce is chiefly made from wine or cider. The acid from wood is procured by distilling hard wood in close vessels: acetic acid is found among the products which come over; this requires redistillation and some subsequent treatment. This variety is termed *pyroligneous acid*.

The strongest acetic acid is prepared by distilling anhydrous acetate of soda with concentrated oil of vitriol. Crystals of hydrate of acetic acid are formed, which may be drained from the more fluid portion. At the temperature of 63° these crystals fuse into a limpid liquid, of a density of 1·063, possessing the pungent smell and taste of vinegar, and capable of blistering the skin. It is soluble to any extent in water and alcohol. Its vapour is inflammable. The water, which is essential to the constitution of acetic acid, is *basic*, and can only be replaced by some metallic oxide; *anhydrous* acetic acid, in a separate state, is unknown.

The *acetates* are all soluble salts; those of silver and mercury are least so. The most important acetates are the acetate and sub-acetate of lead, acetate of ammonia (spirit of Mindererus), and acetate of copper (verdigris).

Acetone, or *pyroacetic spirit*, is a volatile, colourless liquid, which is produced when any of the metallic acetates are subjected to a destructive distillation. It has a density of ·792, and boils at 132°; it is very inflammable, burning with a bright flame.

By distilling together acetate of potassa and arsenious acid, a substance is procured known as the *fuming liquor of Cadet*. This has been proved to be the oxide of a radical, which also has been isolated, named *Kakodyle*, C_4H_6As,—Symb. Kd. It forms, like the other organic radicals, a large number of compounds, all of which are poisonous.

SECTION V.

SUBSTANCES RESEMBLING ALCOHOL.

In the distillation of wood, besides pyroligneous acid, there comes over an etherial body called *wood-spirit* or *wood-naphtha.* There is a remarkable analogy between this substance and alcohol; like the latter, it is the hydrated oxide of a radical, which is termed *methyle*, whose oxide likewise is an ether.

The most important of the methyle series are the following:—

Methyle	C_2H_3, or Me.
Oxide, or Methylic Ether	C_2H_3O
Hydrated Oxide, or Methylic Alcohol	$C_2H_3O + HO$
Chloride of Methyle	C_2H_3Cl
Sulphate of Oxide of Methyle	$C_2H_3So_3$, &c.

Methyle has not yet been isolated.

Oxide of Methyle, Methylic Ether, is, like common ether, obtained by distilling together sulphuric acid and methylic alcohol. It is a gaseous body, colourless, of an etherial odour, inflammable, partially soluble in water; freely soluble in alcohol, wood-spirit, and sulphuric acid; sp. gr. 1·1617. Its compounds are made precisely like the analogous compounds of the oxide of ethyle, only substituting methylic alcohol for common alcohol.

The analogy between the two above-mentioned radicals is still farther carried out in the action of oxygen. By the oxidizement of alcohol we have formed acetic acid; so by the oxidizement of wood-spirit we obtain *formic acid, the hydrated tritoxide of formyle,*—formyle being a hypothetical radical expressed by C_2H.

Formic Acid, $C_2HO_3 + HO$, so named because existing in ants, is obtained in an analogous manner to that employed for procuring aldehyde, only using wood-spirit instead of alcohol.

Prop.—A colourless liquid, of a penetrating odour; boils at 212°; solid at 32°.

No compounds of formyle have as yet been discovered corresponding to aldehyde and aldehydic acid.

Terchloride of Formyle, Chloroform, C_2HCl_3, made by the action of chloride of lime on alcohol, wood-spirit, or acetone, with the aid of heat. It is a thin, colourless liquid, of an agreeable odour, insoluble in water, but soluble in alcohol and ether; sp. gr. 1·49; boils at 141°; not inflammable.

There is still another alcohol, denominated the *amylic* alcohol, because procured by distilling amylaceous substances, as potatoes. It is sometimes called *potato oil.* It is *the hydrated oxide of Amyle*, another organic radical, and its formula is $C_{10}H_{11}O + HO$ (Amyle$=$ $C_{10}H_{11}$).

Its *oxide*, or *amylic ether*, has been isolated, as well as many other of its compounds.

By oxidation, or dehydrogenation of amylic alcohol (as in the corresponding instances of ethylic and methylic alcohol), we obtain an acid—the *valerianic*, $C_{10}H_9O_3+2HO$; this is the hydrated tritoxide of a new radical not yet named, but expressed by $C_{10}H_9$. Valerianic acid is also procured by distilling Valerian root; and also from sugar of milk, by fermentation and a high heat.

SECTION VI.

VEGETABLE, OR ORGANIC ACIDS.

These acids are widely diffused throughout the vegetable kingdom. Many of them pre-exist in the plants; others are the products of the reaction of heat.

Acetic acid, $C_4H_3O_3+HO$, has already been treated of.

Citric acid, $C_{12}H_5O_{11}+3HO$.—This acid is found in the fruits of the genus *citrus*, including the lemon, sour orange, citron, and lime; also in several others, in combination with malic acid. It may be procured by saturating lemon juice with chalk, and then decomposing the citrate of lime by means of sulphuric acid. The citric acid crystallizes on evaporation. It forms colourless prismatic crystals, very soluble in water, of a very sour taste. The three atoms of water which it contains are essential to its constitution.

Malic acid, $C_5H_4O_8+2HO$, derives its name from the apple, in which fruit it largely exists. It may be procured by saturating apple-juice with lime, and decomposing the malate of lime by sulphuric acid. It is a deliquescent acid, without colour, and has an acid taste. It is bibasic.

Lactic acid, $C_6H_5O_5+HO$, derives its name from the word *lac*, the Latin for milk. It is the acid which exists in sour milk. It has lately been shown to be the product of a peculiar fermentation called *viscous*, by which the sugar of milk is converted into lactic acid. It is owing to the generation of this acid, that milk, when kept, becomes *curdled*,—the acid which is formed coagulating the casein. It is monobasic.

Tartaric acid, $C_8H_4O_{10}+2HO$.—This is the acid of grapes, tamarinds, and several other fruits, in which it exists combined with potassa. The tartaric acid of commerce is prepared from the *tartar* or *argol*, an impure acid tartrate of potash, which is deposited from the grape-juice during the process of fermentation. The argol, when purified, and deprived of its colour, constitutes *cream of tartar*. The acid is obtained from this salt by saturating it with carbonate of lime,

by which it is converted into a tartrate of lime, and a tartrate of potassa; the latter is separated from the former, which is insoluble, by filtration; the tartrate of lime is then decomposed by sulphuric acid. It forms colourless, transparent crystals, freely soluble in water, of a sour taste. As it is bibasic, it requires two equivalents of a base to form with it a *neutral* salt; hence, the salts which it forms with a single atom of a fixed base, have an acid reaction, and require the presence of an atom of basic water. Thus, the salt heretofore known as bitartrate of potash (cream of tartar) must now be considered as an *acid tartrate of potash and water.* This salt forms small transparent crystals; it is tolerably soluble in boiling water, sparingly so in cold water; has an acid reaction and sour taste.

There is also a neutral tartrate of potash, called *soluble tartar,* which contains two equivalents of the base united to one of acid.

Tartrate of potash and soda,—Rochelle salts;—made by neutralizing a solution of cream of tartar with carbonate of soda. It forms large prismatic, transparent crystals, freely soluble in water. Acids precipitate cream of tartar from its solution.

Tartrate of antimony and potassa,—Tartar emetic;—made by boiling teroxide of antimony in a solution of cream of tartar; the basic water is displaced by the oxide. Tartar emetic crystallizes in octohedrons with a rhombic base; very soluble in boiling water; has an austere metallic taste. Its solution is decomposed by both acids and alkalies; the former throws down a mixture of cream of tartar and oxide of antimony; the latter, the oxide. Sulphuretted hydrogen precipitates the sulphuret of antimony.

Tartaric acid is distinguished by forming with any salt of potash the well-known cream of tartar.—Heat converts it into *pyrotartaric acid.*

Tannic acid, $C_{18}H_5O_9+3HO$. This is the astringent principle found in many vegetables, as the oak, gall-nut, &c.; it is generally associated with gallic acid. It is best procured by pouring commercial sulphuric ether on coarsely-powdered galls, and allowing it to percolate slowly. The water, which always exists in combination with common ether, dissolves out the tannic acid, while the ether takes up the gallic acid and other matters; hence the liquid which has passed through will consist of two distinct strata, the lower one, which is a concentrated aqueous solution of tannic acid, and the upper etherial solution. The latter having been carefully removed, the tannic acid may be obtained by evaporation. It has a light-yellowish colour; of a porous, feathery texture; has a very astringent but not bitter taste; very soluble in water; less so in alcohol; insoluble in pure ether; has an acid reaction.

Tannic acid yields with the sesqui-salts of iron a deep bluish-black precipitate; it also precipitates the solution of tartar emetic, nitrate of silver, sulphate of copper, and acetate of lead; with gelatin it forms a dense whitish compound,—tannate of gelatin, the basis of leather.

The variety of tannin yielded by kino, catechu, and krameria, gives a *greenish*-black precipitate with the salts of iron.

Leather is made by soaking hides, which have been deprived of their hair, for a considerable time in an infusion of oak bark: the tannin which it contains combines with the gelatin of the skins.

Gallic acid, C_7HO_3+2HO, is usually found combined with tannic acid. It is believed to result from the action of the oxygen of the air upon tannic acid. It is not so soluble in water as tannic acid, nor does it precipitate gelatin, but it yields with sesqui-salts of iron a bluish-black compound.—*Writing ink* is a tanno-gallate of iron.

The remaining vegetable acids are of less importance; the most interesting of them are:

Oxalic acid, C_2O_3+HO, already alluded to.

Benzoic acid,—oxide of benzule,—exists in various balsams. It is best procured from gum benzoin by sublimation. It is in the form of white crystals, very light and feathery; exhales a fragrant odour, not due to the acid itself, but to some of the volatile oil; it forms *benzoates*.

Meconic acid,—exists in opium combined with morphia and codeia. It is characterized by forming a blood-red coloured compound with a sesqui-salt of iron.

SECTION VII.

THE VEGETABLE ALKALIES—VEGETO-ALKALIES.

THE vegeto-alkalies, or *alkaloids*, constitute a peculiar group of compounds. They are met with in various plants, always in combination with an acid, which in many cases, is itself peculiar in its nature, not occurring elsewhere in the vegetable kingdom. They are generally insoluble in water, but dissolve in hot alcohol. Their taste in solution is usually intensely bitter, and their action on the animal economy very powerful, in consequence of which they are of the greatest value as medicines, containing, as they do, the most active properties of the plants in which they are respectively found. They all contain nitrogen, and are complicated in their constitution, having high combining numbers.

The number of these bodies is very large; only the most important will be here noticed.

Morphia, $C_{35}H_{20}O_6N+2HO$,—the active principle of opium;—exists in it as a *meconate;* procured from an infusion of opium by means of ammonia, which throws down the morphia, leaving the meconate of ammonia in solution. It forms small shining crystals, which are colourless; nearly insoluble in water; soluble in hot alcohol; forms solu-

ble salts with the acids, the most important of which are the *sulphate, muriate,* and *acetate.*

Narcotina, $C_{48}H_{24}O_{15}N$,—exists also in opium; it is separated from the other principles by boiling ether, which yields it on evaporation.

Codeia, $C_{35}H_{20}O_5N$—exists in opium as a *meconate;* forms colourless crystals; rather more soluble in water than morphia. Codeia forms salts with the acids.

Other principles found in opium are *Paramorphia* or *Thebain*, *Pseudomorphia*, and *Narceia;* besides *Meconic acid*, which has already been alluded to.

Quinia and *Cinchona*, $C_{20}H_{12}O_2N$(Cinchonia, $C_{20}H_{12}ON$),—the active principles of Peruvian bark;—exist in it in combination with *kinic acid;* procured from an infusion of bark by the action of quicklime, which combines with the kinic acid, liberating the alkalies; these are then to be taken up by boiling alcohol, and decolorized by animal charcoal.

Quinia occurs as a whitish powder; it does not crystallize. Cinchona is in the form of minute crystals. Both are very insoluble in water, but dissolve in boiling alcohol. Their most important salts are the *sulphates*, which are soluble in water.

Strychnia and *Brucia*, $C_{44}H_{23}O_8N_2$ (Brucia, $C_{44}H_{25}O_7N_2$), alkalies existing in the Strychnos nux vomica, St. Ignatius's bean, and false Angustura bark: they are associated with *igasuric acid.*

Veratria, $C_{34}H_{22}O_6N$, the alkaline active principle of the *Veratrum sabadilla*, and of the *Veratrum album*, or white hellebore.

Emetia is the alkaline principle of ipecacuanha. *Colchicina*,—the active principle of the *Colchicum autumnale.* *Solania*,—the alkali of the *Solanum dulcamara.* *Caffeia*, or *Theine*,—the active alkaline principle found both in coffee and tea.

We have also *Atropia*, from belladonna; *Aconitia*, or *Aconitine*, from Aconite; *Daturia*, from stramonium; *Coneia*, from hemlock; *Nicotina*, from tobacco, &c., &c.

Besides the foregoing vegetable alkaline principles, there exist a number of *neutral* principles in plants, possessed of very active properties. Some contain nitrogen, and some do not. The most important of them are *Phloridzin*, *Salicin*, *Asparagin*, *Gentianin*, *Elaterin*, *Cathartin*, *Quassin*, *Lupulin*, *Ergotin*, &c., &c.

SECTION VIII

AZOTIZED VEGETABLE SUBSTANCES.

THESE include *Gluten*, *Vegetable albumen*, *Vegetable fibrin*, and *Vegetable casein*, or *Legumen.* They are sometimes called *vegeto-animal* principles, from their strong analogy with similar principles found in animals.

Gluten.—It owes its name to its adhesive property: to it is due the adhesiveness of wheat-dough. It exists chiefly in the seeds of plants, in combination with starch; — may be separated by washing away the starch from wheat flour. It is almost insoluble in water, but soluble in alcohol; gluey when moist, but yellow and translucent when dry. It is a highly nutritious substance. It is owing to it that the rising of wheaton bread is due; the carbonic acid which is formed by the fermentation of the yeast being entangled in the meshes of the gluten, and thereby imparting the cellular structure to the loaf.

Vegetable albumen, *Vegetable fibrin*, and *Vegetable casein* also exist in vegetables in combination with gluten. Vegetable albumen is coagulated by heat; vegetable casein is coagulated by acetic acid. The chemical composition of all these principles is nearly, if not quite identical, being $C_{54}H_7N_{15}O_{21}$, with some sulphur.

SECTION IX.

OILS AND FATS.

OILS are divided into two classes, *fixed* and *volatile;* the former produce a greasy stain upon paper, which is permanent under the action of heat; the stain produced by the latter is removed by heat. There is no essential difference between oils and fats; the chief distinction is in their different degrees of consistency. All of them have more or less attraction for oxygen; some of them to such an extent as to produce spontaneous combustion of light substances moistened with them; this is very apt to be the case with *linseed oil.* From this results the division of fixed oils into drying and non-drying. The oils used in painting belong to the first class.

The parts of vegetables which contain most oil are the seeds; olive oil is obtained from the fruit itself.

The fixed oils have but slight odour or taste; whenever these qualities are found in a fixed oil, they are due to a volatile principle associated with it, as in the case of butter. They are all insoluble in water, but slightly soluble in alcohol, with the exception of castor oil, but soluble in ether and in volatile oils.

Although oils appear to be homogeneous, they in reality consist of several proximate principles. Of these, the most solid one in animal oils is called *stearin;* in vegetable oils, *margarin;* the most liquid in both is named *olein*, or *elain.* These principles may easily be isolated by submitting the whole to boiling alcohol, which, on cooling, deposits the margarine and stearine, but retains the olein. The margarine may be then separated from the stearine by ether, and the olein from the alcohol by distillation. These three principles consist respectively

of an acid, united with a base. The acid is named *oleic*, *stearic*, and *margaric;* the base is the same for each; it is called *glycerine.*

When any of the fixed oils or fats is mixed with an alkali, a change takes place denominated *saponification*, resulting in the formation of a *soap;* the several acids just mentioned quit the glycerine with which they were united, and combine with the alkali. Thus common soap, made by the action of potassa on fat, consists chiefly of a stearate of potassa. If a soap be decomposed by an acid, the particular fat acid of which the soap may have been constituted will be precipitated. The formation of the lead plaster is a true instance of saponification, the oleo-margarate of lead being formed, and the glycerine remaining in solution.

Spermaceti. — This substance is found in the cranium of a certain species of whale, in union with an oil. It has a crystalline structure, melts at 120°, is soluble to some extent in boiling alcohol, also in ether. It is saponified with difficulty, two substances resulting, called *ethal* and *ethalic acid.*

Wax.—This substance, whether procured from the bee, or from the pollen and leaves of flowers, is found to consist of two distinct principles termed *cerine* and *myricine;* these principles may be separated by boiling alcohol.

All the fixed oils are compounds of carbon, oxygen, and hydrogen.

Volatile Oils.—These are very numerous, and impart the peculiar odours to plants. They are procured from the various parts of plants by distillation with water, common salt being sometimes added to elevate the boiling point.

When pure, they are colourless, but they generally have a slight tinge; they have a powerful odour and strong taste; do not saponify; absorb oxygen when exposed to the air; are freely miscible with the fixed oils; are very slightly soluble in water; freely so in alcohol and ether. They consist of two proximate principles, analogous to those of the fixed oils, and named *stearoptin* and *elaoptin.*

Some of the volatile oils consist solely of carbon and hydrogen, as the *oil of turpentine;* others of carbon, hydrogen, and oxygen; and a few contain sulphur, as the oils of mustard, horseradish, &c.

Camphor is a solid volatile oil, having all the characters of the essential oils.

Resins.—These are generally found in vegetables associated with some volatile oil. Common rosin affords a good example; it is procured from turpentine, which is a compound of rosin and the volatile oil of turpentine. When turpentine is distilled, the oil passes off, leaving the rosin behind.

Resins are insoluble in water, but soluble in alcohol, and in volatile and fixed oils; they are inflammable, and yield on distillation carburetted hydrogen, and several other products; a moderate degree of heat imparts an adhesive quality to them. Some resins resemble fixed oils, in containing two principles, one being more soluble in alcohol than

the other. Resins are also susceptible of saponification. Concentrated nitric acid acts upon resins with an explosive violence.

The most important resins, besides *rosin*, are *lac*, *copal*, *mastic*, and *dragon's blood.*

Amber is a fossil resin.

Caoutchouc, or *India rubber*, is an exudation from a tree, resembling both the volatile oils and the resins. It is peculiar in being *elastic.*

Gutta Percha is a concrete juice from a tree growing in Borneo. It resembles caoutchouc in many respects.

Balsams.—This term is properly used to express a native compound of resin, volatile oil, and benzoic acid, as in the balsams of Tolu and Peru. The name is also improperly given to compounds of resins and volatile oils, as copaiva.

The term *Gum-resins* is applied to a class of vegetable substances, consisting of a mixture of gum and resin, with some other principles: they comprise some of the most valuable medicines, as *opium*, *gamboye*, *ammoniac*, *asafœtida*, *myrrh*, *scammony*, &c.

SECTION X.

ANIMAL COMPOUNDS.

Protein and its compounds.—The most important protein compounds are *Albumen*, *Fibrin*, and *Casein.*

Albumen exists in eggs and the serum of the blood,—being combined in the latter with soda: the white of an egg affords a good example of it. It is not soluble in water, unless a little alkali be present; coagulates by heat, acids, creasote, alcohol, and electricity; it gives precipitates with most of the metallic salts, particularly *corrosive sublimate*, for which it is the best antidote.

It is composed of carbon, oxygen, hydrogen, nitrogen, sulphur, and phosphorus;—or supposing *protein* to be represented by Pr, the formula for albumen would be, $Pr+P+S_2$.

Fibrin constitutes the chief portion of muscular flesh; it is also an important constituent of the blood, in which it exists in the soluble state. It may be procured either from muscle, or preferably, by whipping freshly-drawn blood with a twig; the fibrin adheres to it in long white filaments. Its characteristic is its spontaneous coagulation; it is in consequence of this tendency that blood coagulates when drawn from the body. Its composition is very nearly identical with that of albumen,—containing one equivalent less of sulphur. Albumen is

converted into fibrin, in the living body, in the process of organization. Its proportion in the blood is liable to variation by disease.

Casein is found in milk, and is the basis of cheese. It closely resembles albumen, but differs from it in not being coagulable by heat. In composition it is nearly identical with the two foregoing substances, but it contains no phosphorus.

From either of the above three compounds, protein may be procured, by dissolving them in an alkaline solution, and then precipitating by an acid.

Gelatin and Chondrin.—These principles constitute the bases of skins, tendons, cartilage, and fibro-cartilage, &c. Any of these, when boiled for a long time in water, yield a jelly, which, on cooling, solidifies into *gelatin* or *glue. Isinglass* is the dried swimming-bladder of the sturgeon. *Chondrin* is very analogous to gelatin; it is procured in the same manner, from *cartilage.* Both are soluble in hot water. Gelatin is characterized by giving a precipitate with tannic acid,—*tannate of gelatin.*

The different solids and fluids of the body all contain various interesting principles, as for example, *blood, urine, chyle, bile, bones, nerve-substance,* &c.; but the space here allowed will not permit an examination of them. In fact, they more properly come under the division of PHYSIOLOGY, to which the student is referred for an account of them.

A

HAND-BOOK

OF

MATERIA MEDICA

AND

THERAPEUTICS:

WITH

TWENTY-NINE ILLUSTRATIONS.

(683)

CONTENTS.

GENERAL REMEDIES.

LOCAL REMEDIES.

MATERIA MEDICA.

Medicines are substances which have the power of so modifying the actual state of the organs — the solids and fluids, — as to render them applicable to the cure of disease. They differ from *remedies*, which are of a more generic nature, and which include all the various means—moral as well as physical—employed to alleviate or cure disease: thus heat, cold, electricity, a surgical operation, the influence of the emotions, &c., are all remedies, but cannot be called medicines.

Materia Medica is the science which treats of medicinal substances; Therapeutics — the application of remedies to the treatment of disease; Pharmacy is the art of compounding or preparing medicines for use; Toxicology embraces the consideration of their *poisonous* effects.

A complete knowledge of medicines includes an acquaintance with their *physical characters*, such as their colour, taste, odour, general appearance; their *chemical properties;* their *natural* and *botanical history;* their *modes of growth, collection, preservation*, &c.; their *therapeutical applications;* their *physiological properties*, or their method of affecting the healthy system; and their *toxicological properties*, or their poisonous effects. It is hence obvious that a correct knowledge of Materia Medica presupposes some acquaintance with Natural History, Botany, and Chemistry; and that of Therapeutics requires some familiarity with Anatomy and Physiology, and also with the principles of Mental and Moral Philosophy, as well as of the general powers or forces of nature, such as light, heat, electricity, and magnetism.

Along with medicines proper, it is usual to consider a set of substances called *aliments*, which are often very useful as therapeutic agents, though they cannot be considered as *medicinal* in their action. They possess nutritive qualities, and when swallowed, they are digested and converted into chyle. Medicines, on the contrary, are not *assimilated*, through the digestive process, but, after being absorbed into the circulation, produce some vital or chemical modification of the blood itself, of the various secretions, or of the ultimate molecules of which the tissues of the body are composed.

EFFECTS OF MEDICINES.

The effects of medicines vary very considerably; they may conveniently be divided into *primary*, or those which are more immediately apparent; and *secondary*, or those which follow the primary as a consequence; the latter are sometimes termed the *remote* effects of medicines, and, as these are generally aimed at in the treatment of disease, the *therapeutical effects*. An example or two will best illustrate this difference: the primary effect of a cathartic is to empty the bowels; one of its secondary effects is to deplete from the circulation; hence we employ purgatives in fevers and inflammations. The primary operation of a diuretic is to increase the secretion of urine; a secondary effect is to promote absorption; hence it proves beneficial in dropsy. In fact, medicines are rarely used, comparatively speaking, for their primary effects, but almost always for their secondary operations. In some cases, however, the two are not distinct, the primary becoming the therapeutical effect,—as the action of digitalis on the heart, or that of opium in relieving pain.

As the effects of medicines upon the system are not absolute, but relative, and influenced by various circumstances, it follows that no remedy can be regarded essentially as a *specific*, since what might be applicable to the disease under one condition, might be equally injurious under a different one.

The primary effects of medicines may take place either in the parts to which they are applied, or in parts of the system remote from the point of application. The former are termed their *local* effects; the latter, their *remote* or *constitutional* effects.

1. The *local action* of medicines requires no explanation; it is that which occurs in the part to which the medicine is immediately applied, as vesication from a blister, cauterization from the application of an escharotic, &c.

2. The *remote* or *constitutional* effects of medicines are produced by their *absorption into the blood.* Medicinal impressions cannot result from mere nervous communication between distant parts, since, when the circulation is interrupted, even though the nerves are untouched, poisons fail to act, as has been often shown by experiments upon animals. And, on the other hand, if the blood-vessels remain entire, while the nerves are severed, poisons will produce their effects upon distant parts of the system. The *absorption of medicines into the blood* is also proved by the fact, that they have been detected, after being swallowed, in the different secretions, in the solid tissues of the body, and in the blood itself. Thus rhubarb and turpentine have been found in the urine; alcohol in the exhalation from the lungs; sulphur and mercury in the perspiration; garlic, various purgatives, narcotics, and other medicines in the milk; lead in the brain and muscles; silver in the skin; and so on.

As regards the *method* by which medicines gain admission into the

blood, there can be but two avenues—the lacteals or absorbents, and the veins. From various experiments made upon the lacteals, it is highly probable that their chief, if not exclusive function, is to take up *alimentary* substances—such as can be converted into chyle: medicinal substances have been very seldom found in them. On the other hand, experiments are equally strong in proving, that the *veins* are chiefly concerned in the absorption of medicinal substances; thus Magendie found that if the lacteals be tied, nux vomica will affect an animal in six minutes, while, if the veins be tied, no effect is produced. The mode by which absorption is effected is entirely physical, or by *endosmose.* The *rapidity* of absorption is influenced by a variety of circumstances, as the part or tissue to which the medicine is applied, the nature of the medicine itself, chiefly as regards its *solubility*, the condition of the system, &c. It is said to be the greatest from the bronchial mucous membrane.

To be absorbed, medicines must be in a state of solution. Some substances, however, although insoluble, are brought to a soluble condition by the gastric liquor. Thus, metallic iron is converted into a soluble salt by the acids of the stomach.

Medicines may be said to affect the system in three ways,—*physically* or *mechanically*, *chemically*, and *vitally* or *dynamically*.

Instances of the *mechanical* action of medicines are afforded in the case of many of the anthelmintics, which expel worms from the bowels simply by the mechanical irritation produced; also in the case of bran, which is believed to act as a laxative in a similar manner; and metallic mercury has been employed to overcome intro-susception of the bowels, by virtue of its gravity.

As regards the *chemical action* of medicines, there is every reason to believe that remedies obey the same chemical laws in the living body as they do out of it. We can actually *see* it in the case of caustics, whose action upon the skin is purely chemical; an excess of acid in the stomach and bowels, and even in the blood, is corrected by the use of alkalies—a strictly chemical action. Many other examples might be cited. Indeed it is highly probable, from the very complex character of the blood, and its consequent facility of decomposition, that many medicines which enter the circulation act by *chemically changing its character*, and chiefly, through its azotised principles,—albumen, &c.

Medicines are, however, not to be considered as confined in their effects, to any single one of the above methods. They frequently partake of a mixed character, as chemico-vital or physico-vital.

Certain medicines have been found to evince a natural preference for certain organs; thus, an emetic for the stomach, a cathartic for the bowels, &c.; and this, too, no matter in what way the medicine be introduced into the system; thus tartar emetic or emetia will vomit even if injected into the blood-vessels. No satisfactory explanation can be given of this; we can only ascribe it to a *natural affinity* supposed to

exist between the medicine and the particular part; but this is obviously no explanation of the phenomenon.

Again, medicines are sometimes regarded as divisible into two opposite classes—*stimulants* and *sedatives*. This, however, cannot strictly be affirmed, since different states of the system may produce quite opposite results from the same medicine. This is well illustrated in the effects of the too long-continued use of tonics and stimulants: the result is debility.

CIRCUMSTANCES MODIFYING THE ACTION OF MEDICINES.

There are various circumstances which modify the action of medicines upon the system; these may depend upon the medicine itself, as respects its dose, mode of combination, &c., or upon the condition of the organism at the time of its administration. Under the latter head, the most important circumstances are:—

1. AGE.—The young are much more susceptible to the action of medicines than the middle-aged. Old persons are less able to bear overdoses than the middle-aged. It is difficult to lay down any precise rule upon the subject: that of Dr. Young is often adopted; it is "to diminish the dose of most medicines, for children under 12 years, in the proportion of the age to the age increased by 12;" thus at 2 years it would be $\frac{2}{2+12}=\frac{1}{7}$, &c. At 21, the full dose may be given. There are certain medicines, however, which cannot be given to young children according to the above rule; thus calomel and castor oil require to be given in larger proportionate doses; whilst the narcotics, and some of the metallic preparations, must be administered in much smaller proportionate quantities.

2. SEX.—Females, as a general rule, require smaller doses than males. The peculiarities of their system, at the different periods of menstruation, pregnancy, and lactation, must also be borne in mind.

3. HABIT.—The effect of habit, in accustoming to the action of a medicine, is well known; it is well illustrated in the case of alcohol and opium. The influence of acrid or irritating substances is but little diminished by repetition.

4. DISEASED CONDITION OF THE BODY.—This is well seen in the power of the system to bear very large doses of opium in tetanus and mania à potu, and of the different effects of calomel in different conditions of the system.

5. TEMPERAMENT AND IDIOSYNCRASY will also modify the action of medicines. These should always be ascertained in the administration of our remedies.

6. TISSUE, OR ORGAN.—The stomach is much more susceptible than the skin; carbonic acid, when inhaled into the lungs, acts as a poison; when swallowed into the stomach, it merely proves a grateful stimulant.

7. THE TIME OF ADMINISTRATION also exercises an influence; a medicine acts more promptly and powerfully on an empty stomach.

8. MENTAL EMOTIONS.

ADMINISTRATION OF MEDICINES.

Under this head may be included the parts to which medicines are applied, with the mode of their application, and the forms in which they are employed.

The parts of the body to which medicines are most usually applied, are the stomach, rectum, skin, mucous membrane of the lungs, nostrils, vagina, bladder, and urethra.

The *stomach* is most frequently resorted to, both on account of the facility of administration through it, its great susceptibility, and its intimate relation with other parts.

The *rectum* is employed, where the patient cannot swallow the medicine, or where there is some objection to giving it by the mouth, or when a local impression is desirable. Medicines thus employed are called *enemata*, or *clysters*, or *injections*. If introduced in the solid state, they are named *suppositories*. The dose of the medicine, as a general rule, is three times that given by the stomach, though there are exceptions. When intended to be retained so as to impress the system, the *bulk* of the vehicle should be as small as possible.

The *skin* is frequently made use of as a means of affecting the system by remedies. These may be applied either *enepidermically* or *endermically*,—that is, to the sound skin, or to the skin deprived of its cuticle. The endermic method is by far the most prompt and powerful. The cuticle is best removed by means of a small blister: and the proper parts for the application are the epigastrium, and the insides of the limbs. The usual dose is three times the quantity given by the mouth; and the powdered substance should be properly diluted, before being sprinkled upon the denuded surface. The circumstances which may demand the endermic method of administration are inability or indisposition of the patient to swallow, or of the stomach to retain the medicine; inflammation of the gastric mucous membrane, or a want of susceptibility of this part to the action of the medicine, from frequent repetition; the necessity in urgent cases, of introducing medicines in all possible modes; the indication that may exist to produce revulsion from internal parts; and the necessity for procuring the local effects of the remedy.

When the cuticle is not removed, the medicines may be applied in various manners; thus, where their local effects alone are wanted—by lotions, fomentations, cataplasms, &c.; where their general impression is desired—by inunction, baths, and vapour. The most simple form of administering a vapour bath, is to elevate the patient's knees under the bedclothes, and to place at his feet hot bricks enveloped in wet flannels; the vapour which is given off has thus free access to the body. Another method is to place the patient in a tub of warm water, enveloping him in a blanket, after which a number of hot bricks are to be placed in the tub, until the requisite amount of steam is generated. Another method, recommended by Dr. Serres, is to place a

piece of quick lime in a wet cloth, and then wrap it up in a dry cloth, and place it in the bed. If the vapour of a solid substance, as sulphur, is required, the patient is to be placed in a properly-contrived apparatus, and the solid body sprinkled in powder on a hot iron at his feet.

The *mucous membrane of the bronchi* may also be employed for the introduction of medicines. They are applied here usually in the form of vapour, by means of an inhaler; or, when this cannot be had, by means of a teapot or basin, with an inverted funnel. It is not recommended to blow fine powders into the lungs.

Occasionally, medicines are introduced into the *nasal* or *pituitary membrane;* they are however employed, in this manner, generally with a view to their local impression. When they produce a discharge, they are called *errhines;* when sneezing, *sternutatories.*

The practice of *introducing medicinal substances through the veins* has been occasionally resorted to; but it is not recommended, in consequence of the danger of the introduction of air, which is attended with fatal consequences.

FORMS OF MEDICINES.

Medicines are used in the solid or fluid state, each of which comprises several forms.

I. SOLID FORMS.

These include *pills, powders, confections, troches, electuaries,* and *extracts.*

PILLS. (*Pilulæ,* U. S.)—Small globular masses, intended to be swallowed without chewing; they should not consist of substances required to be given in large doses, nor of salts which are deliquescent or efflorescent, although the latter may be rendered fit by first driving off the water of crystallization by heat. Some substances require only the addition of water; others, the intervention of some viscid body, as gum or sugar. The heavy metallic powders may be mixed with soft extracts or confections; the light vegetable powders, with syrup, honey, or mucilage. When the requisite consistence has been given to the mass, it is to be properly rolled out by means of a spatula, and then divided into the requisite number of pills. Sometimes they are covered with gelatine, to conceal their disagreeable taste.

POWDERS. (*Pulveres,* U. S.)—Such medicines are given in the form of powder as are not very bulky, nor of very disagreeable taste, and have no corrosive property. Deliquescent substances, and those containing much fixed oil, are unfit to be used in powder; as also such crystalline salts as contain water of crystallization, unless this be previously expelled by heat. The substance may be reduced to the state of powder, by means of a mortar and pestle, made either of metal, glass, or Wedgwood. The coarser particles are separated by sieves

made of various materials. Some require to be submitted to the processes of *levigation* and *elutriation.* By the former of these terms is meant the rubbing of the substance, previously moistened, between two smooth pieces of hard flat stone; the latter term signifies the agitation of the matter in water, allowing the coarser particles to settle, pouring off the liquor for the finer ones to subside, and lastly, decanting and drying the powder. Some medicines deteriorate when kept in the powdered state. They are also more liable to adulteration.

The lighter powders may be administered suspended in water, or any other convenient vehicle: the heavy insoluble ones, in syrup, molasses, or honey.

TROCHES. (*Trochisci*, U. S.)—Small solid masses, in which the medicinal substance is incorporated with sugar and gum,—intended to be held in the mouth and allowed slowly to dissolve. They are used chiefly in affections of the throat.

CONFECTIONS. (*Confectiones*, U. S.) — Soft solids, made by incorporating medicinal substances with sugar: they comprise also *conserves.*

ELECTUARIES. (*Electuaria.*) — Usually extemporaneous prescriptions, made by mixing medicines (generally powders) with honey or molasses.

EXTRACTS. (*Extracta*, U. S.) — These are either solid or fluid. The former are usually prepared by evaporating either the expressed juice, or the infusion or decoction; the latter, by the addition of sugar to the concentrated infusion, decoction, or tincture.

II. LIQUID FORMS.

These include *decoctions*, *infusions*, *solutions*, *medicated waters*, *mixtures*, *tinctures*, *wines*, *spirits*, *ethers*, *oils*, *syrups*, *vinegars*, *oxymels*, and *honeys.*

DECOCTIONS. (*Decocta*, U. S.)—Preparations in which the active properties of vegetables are extracted by boiling. The boiling should take place in a covered vessel. Certain vegetables are unfit for decoction, as those which possess a volatile oil, or an active principle decomposed by heat, or such as contain much inert, starchy, or mucilaginous matter.

INFUSIONS. (*Infusa*, U. S.)—These differ from decoctions in not being boiled. They may be made either with cold or boiling water. Cold water is preferred where the active principle is volatile, or easily injured by heat, or where it is desirable to avoid the solution of some principle which is insoluble at a low temperature. Both infusions and decoctions usually require to be *filtered;* this process may be performed either by using unsized paper in a common funnel, or by *percolation* or *displacement.*

SOLUTIONS. (*Liquores*, U. S.)—Preparations in which substances are simply dissolved in water; as *liquor calcis* or *lime-water.*

Medicated Waters. (*Aquæ Medicatæ*, U. S.)—These are water impregnated with different essential oils; they are usually made by first rubbing up the oil with carbonate of magnesia, and then adding the water, and filtering.

Mixtures. (*Misturæ*, U. S.)—These consist generally of one or more insoluble substances, suspended in water by means of gum, sugar, or yolk of egg. When an oil is suspended in this way, the mixture is called an *emulsion.* A good deal of care and dexterity is requisite in making a uniform mixture.

Tinctures. (*Tincturæ*, U. S.)—Solutions of medicated substances in alcohol, or diluted alcohol. They are usually macerated, at ordinary temperatures, in well-stopped bottles, frequently agitating. *Undiluted* (officinal) alcohol is employed where the substance to be dissolved is insoluble in water,—as resins, essential oils, &c.; but *diluted* alcohol is preferred when the substance is soluble both in alcohol and water.

Wines. (*Vina*, U. S.)—Are solutions in wine. The only wines proper for use are Madeira, Sherry, or Teneriffe.

Spirits. (*Spiritus*, U. S.)—These are alcoholic solutions of volatile principles, and are prepared either by distillation, solution, or by maceration.

Ethers. (*Æthera*, U. S.)—These require the action of acids on alcohol.

Oils.—The *distilled oils* (*Olea Destillata*, U. S.) are prepared by distillation from the substances containing them. The *fixed oils* (*Olea Fixa*), by expression; as *olive oil*, &c.

Syrups. (*Syrupi*, U. S.)—Preparations in which the medicinal substance is preserved in a concentrated solution of sugar. *Simple syrup* consists of two and a half pounds of white sugar dissolved in a pint of water. *Medicated* syrups are made either by adding the proper amount of sugar to vegetable infusions, decoctions, juices, &c., or by adding the tincture of the substance to simple syrup, and afterwards driving off the alcohol by the heat of a sand bath.

Honeys. (*Mellita*, U. S.)—These are analogous to syrups, the difference being that honey is employed to preserve the medicinal substance, instead of a solution of sugar. They are said to be less apt to become candied.

Oxymels are preparations in which honey and vinegar are combined.

Vinegars. (*Aceta*, U. S.)—Liquids in which distilled vinegar is employed as the solvent.

Besides the above forms of medicines, which are employed for internal administration, there are several others which are used exclusively as external applications; these are *liniments, ointments, cerates, plasters,* and *cataplasms.*

Liniments. (*Linimenta*, U. S.)—Oily compounds intended to be applied to the surface by bathing, or by saturating cloths with them.

OINTMENTS. (*Unguenta*, U. S.)—Soft solids which melt at the temperature of the body.

CERATES. (*Cerata*, U. S.)—These are rather harder than ointments: they do not melt at the temperature of the body. *Simple cerate* consists of fresh lard and white wax.

PLASTERS. (*Emplastra*, U. S.)—These are solid at ordinary temperatures, and require to be heated before they can be spread. They are usually kept in rolls, and when wanted for use are spread upon sheepskin, linen, muslin, or even paper; a small margin being left at the edges uncovered.

CATAPLASMS *or* POULTICES.—These are soft moist preparations, intended to relax and soften the parts to which they are applied. They are usually made from bread and milk, flaxseed meal, &c.

The *weights* and *measures* recognised by the Pharmacopœia in the compounding and dispensing of medicines are the *Apothecaries' weight*, and the *Apothecaries'* or *wine measure*, though medicines are purchased and sold by the wholesale dealer by the *Avoirdupois weight*. The imperial pint of the British Pharmacopœia (not recognised by the U. S. Pharmacopœia), contains *twenty* fluid ounces. The common pint contains only *sixteen* ounces.

The following are the denominations, together with their symbols, which are employed in prescription:—

Pound, ℔; ounce, ℥; drachm, ʒ; scruple, ℈; grain, gr.; gallon, Cong. (congerius); pint, O (octarius); fluid ounce, f℥; fluid drachm, fʒ; minim, ♏.

A *drop* is not always equivalent to a minim, since it varies in size according to the nature of the fluid, and the shape and size of the vessel from which it is dropped. In the case of water, the minim and drop are the same; in alcohol there are two drops in each minim; in ether, there is a still greater difference. *Chloroform* contains from 250 to 300 drops in a fluid drachm.

Besides the above weights and measures, it is frequently found convenient to employ *approximative* measurements, in prescribing medicines. The following are the most common:

A *teacup*,—estimated to hold about four fluid ounces,		(f℥iv.) or a gill.
A *wineglass*,	" " two fluid ounces, -	(f℥ij.)
A *tablespoon* (cochlear magnum),	- - -	(f℥ss.) half a fluid ounce.
A *teaspoon* (cochlear parvum),	- - - -	(fʒj.) a fluid drachm.

CLASSIFICATION OF MEDICINES.

The great diversity of the effects of different medicines, renders an attempt at their classification very desirable. Classifications of medicines may be divided into *empirical* and *rational* ones. As an example of an empirical classification, the *alphabetical* order may be cited, since this method is founded on names which are arbitrary, and have no relation to the bodies which they are intended to represent. All

its supposed advantages—as, for example, that of facility of reference—may be obtained from a well-constructed index.

The *rational* arrangements are such as have an actual relation with the bodies for which they are used, being founded on the properties of the medicines themselves, or on their mode of affecting the economy. Thus medicines may be grouped, according to (1) their *sensible* properties, as colour, taste, and smell; (2) their *chemical* properties; (3) their *natural-historical* properties; (4) their *therapeutical* properties; (5) their *physiological* properties.

Valid objections may be urged against all the above systems of arrangement, with the exception of the *physiological* system, which is here adopted, as being the safest guide both to the student and practitioner.

By the *physiological classification* is meant one founded on the relation which medicines bear to the system in a state of health. Medicines may be arranged *physiologically*, on two principles,—according to the parts or organs which they affect, or according to the nature or quality of the action which they set up. It would be almost impossible to base an arrangement exclusively upon either of these methods; but some authors form their principal divisions or *classes* of medicines from the parts acted on, and their *orders* from the nature or quality of the effect, or *vice versâ*. The following system of classification is founded upon the *physiological* method.

Medicines may be considered as acting either upon the solids and fluids of the body, or upon foreign matters contained in the body. This affords the grounds for their primary division into two separate classes: most medicinal substances belong to the former class.

Of those medicines which act upon the solids and fluids of the body, some may exert their influence upon the system at large, either through the medium of the circulation or that of the nervous system; whilst others confine their operation to some especial organ, as the kidneys, the lungs, the skin, &c.: the former are termed *general remedies;* the latter, *local remedies.*

General remedies are divisible into three orders: *stimulants*, which elevate the system above the natural standard; *sedatives*, which depress it below the natural standard; and *alteratives*, which act by slowly changing the nutrition, and thereby superseding diseased action.

Stimulants may be divided into *permanent stimulants* and *diffusible stimulants;* the former include the two ultimate classes of *astringents*, or medicines which excite the vital contractility of the tissues; and *tonics*, which increase the vital tonicity of the system. Diffusible stimulants include the two divisions of *arterial stimulants* and *cerebro-nervous stimulants.* The latter are divided into *cerebral stimulants*, or *stimulant narcotics; nervous stimulants*, or *antispasmodics;* and *excito-motor stimulants*, or such as affect the spinal centres so as especially to excite the motor nerves.

Sedatives comprise only the two ultimate classes of *arterial sedatives*,

sometimes named *refrigerants*, and *nervous sedatives*, or *sedative narcotics*.

Local remedies are divided into three orders; *those affecting the functions; those affecting the organization;* and *those which act mechanically*. The medicines which affect the functions include the eight following classes: *emetics*, which act upon the stomach; *cathartics*, which act upon the intestines; *diuretics*, which increase the secretion of the kidneys; *diaphoretics*, which promote perspiration; *expectorants*, which increase the pulmonary and bronchial secretion, or facilitate its expulsion; *emmenagogues*, which facilitate the menstrual discharge; *sialagogues*, which stimulate the salivary glands; and *errhines*, which increase the secretion of the nasal mucous membrane.

The medicines affecting the organization comprise the three classes of *epispastics*, or such as vesicate or blister the skin; *rubefacients*, or such as inflame the skin; and *escharotics*, or such as destroy the life of the part.

The medicines operating mechanically are the *demulcents*, which act by protecting the surfaces to which they are applied, from irritation; *emollients*, which soften and relax the skin; and *diluents*, which act by diluting the fluids of the body.

The second great division, embracing substances which act on foreign matters within the body, comprises only two subdivisions: *antacids*, or medicines which neutralize acid in the system; and *anthelmintics*, or such as destroy and expel worms from the alimentary canal.

The following table presents a synopsis of the foregoing arrangement. It is the one adopted by Prof. Wood, and somewhat modified by Prof. Carson.

TABLE OF CLASSIFICATION OF MEDICINES.

I. SUBSTANCES WHICH ACT UPON THE SOLIDS AND FLUIDS OF THE BODY.

General Remedies.	Stimulants,	Permanent,	Astringents.	
			Tonics.	
		Diffusible,	Arterial,	
			Cerebro-nervous,	Cerebral,
				Nervous,
				Excito-motor.
	Sedatives.	Arterial, or Refrigerants,		
		Nervous, or Sedative Narcotics.		
	Alteratives.			
Local Remedies.	Affecting the functions.	Emetics,		
		Cathartics,		
		Diuretics,		
		Diaphoretics,		
		Expectorants,		
		Emmenagogues,		
		Sialagogues,		
		Errhines.		

Local Remedies
- Affecting the organization.
  - Rubefacients,
  - Epispastics,
  - Escharotics.
- Acting mechanically.
  - Demulcents,
  - Emollients,
  - Diluents.

II. SUBSTANCES WHICH ACT ON FOREIGN MATTER IN THE BODY.

Antacids,
Anthelmintics.

The classification adopted by Prof. Biddle has reference to the action of medicines upon the *blood*, the *secretions*, and the *nervous system*. Thus, some medicines, as iron, mercury, iodine, acids, alkalies, and others, after their absorption into the blood, either combine with some of its constituents or in some way modify them: they are termed *Hœmatics*. Other medicines pass through the blood, without essentially influencing it, but in their elimination from the system of the secretions, either increase or alter their action; they are termed *Eccritics*. And a third class acting little or not at all upon the blood or secretions, direct their influence to the nervous system; they are termed *Neurotics*. The classification based upon this division is here given .

- I. Neurotics (from νευρον, a nerve).
  - Narcotics,
  - Antispasmodics,
  - Tonics,
  - Astringents,
  - Stimulants,
  - Sedatives,
  - Spastics.
- II. Eccritics (from εκκρισις, secretion).
  - Emetics,
  - Cathartics,
  - Diaphoretics,
  - Diuretics,
  - Blennorrhetics,
  - Emmenagogues.
- III. Hœmatics (from αιμα, the blood).
  - Hœmatinics.
  - Alteratives,
  - Antacids.
- IV. Topical Remedies.
  - Irritants,
  - Demulcents,
  - Anthelmintics.

GENERAL REMEDIES.

CLASS I.

ASTRINGENTS.

"Medicines which produce contractility of the living tissues." This effect is by some ascribed to a *vital* stimulant influence over the organic contractility; others attribute it rather to a *chemical* operation upon the albumen and gelatine of the tissues. Their *general* chemical effect is certainly controlled by vitality; but their *local* chemical operation is much the same as upon dead animal matter.

The obvious effects of astringents are contraction and shrinking of the parts to which they are applied, diminution of secretions, and of hemorrhagic discharges, a harder and fuller pulse, together with greater tonicity of the muscles.

They are used chiefly to arrest morbid discharges, whether hemorrhagic or by secretion; but they should not be prescribed in the early or inflammatory condition. They are also used in diseases connected with relaxation of the tissues. Among the special disorders calling for their employment are *chronic diarrhœa* and *dysentery*, *passive hemorrhages*, *profuse bronchial discharge*, *catarrh of the bladder*, &c.; and *locally*, in gonorrhœa, leucorrhœa, otitis, ozœna, and ulcers.

They may be conveniently divided into the two classes of Vegetable and Mineral astringents. The former depend for their astringency on a principle common to all of them, named *tannic acid;* the latter possess no such common principle, but each one of them is peculiar in its effects upon the system.

VEGETABLE ASTRINGENTS.

Acidum Tannicum, U. S. (*Tannic Acid.*) — Exists in vegetable astringents in combination with *gallic acid;* the latter, however, is produced by the oxidation of tannic acid. Tannic acid is best obtained by the action of commercial sulphuric ether on powdered galls, allowing it slowly to percolate through them; the water of the ether dissolves out the tannic acid, which may be separated by evaporation.

Prop.—A light porous substance, of a yellowish-white colour; very soluble in water and dilute alcohol, and of a purely astringent taste There are two varieties, one found in galls, oak-bark, &c., characterized by yielding a *blue-black* precipitate with the persalts of iron; the other found in kino, &c., yielding a *greenish-black* colour. *Incompatibles*,— mineral acids, alkalies, vegetable alkalies, the persalts of iron, and gelatine. It acts on the system as a pure astringent; — useful in diarrhœa and some forms of local hemorrhage. Dose, 3 to 5 grains three or four times a day.

Oak Bark. (*Quercus.*) — The officinal varieties of oak bark are

the *Q. alba*, U. S., or *white oak bark*, and *Q. tinctoria*, U. S., or *black oak bark;* though other species may contribute to furnish the shops. White oak bark is recognised by its whitish epidermis and superficial furrows; internally, it has a light-brown colour and fibrous texture; taste, bitter and astringent; does not tinge the saliva. Black oak bark is darker coloured externally, more deeply furrowed, has a more bitter taste, and imparts a yellow colour to the saliva in consequence of its containing a peculiar principle, *quercitrine;* this principle renders the black oak bark valuable as a dye. Both impart their virtues to water and alcohol. They contain tannic and gallic acids. Not much used internally. The white is astringent; the black frequently purges from the irritation it causes. Oak bark is employed externally in the form of bath for marasmus, or chronic diarrhœa; also as a lotion, or poultice, to indolent and gangrenous ulcers, and as a gargle in sore-throat. Dose, of powder, 30 grs.; of the decoction (*Decoctum Quercus Albæ*, U.S.), f℥ij; of the extract, 10 to 20 grs. The oak leaves and acorns are also astringent; the latter have been used in scrofula.

Galls. (*Galla*, U. S.) — Excrescences produced by the puncture of an insect upon the young twigs of the *Quercus infectoria*, a native of Asia Minor. The market is chiefly supplied from the ports of the Levant; they are named *Aleppo galls.* There are two varieties, the *blue* and the *white;* the former are the smallest, most compact, and most valuable; the latter are of a yellowish-brown hue, lighter, and have a perforation which indicates that the insect which they contained has made its escape. The blue galls are to be preferred; they are round, but with a tuberculated surface, have a flinty fracture, no odour, a bitter and very astringent taste, yield their virtues to water and alcohol; they contain much tannic and some gallic acid. *Incompatibles,*—the same as of tannin.

Uses. — Chiefly externally, in the form of decoction, as a gargle, or lotion; also as an ointment (*Unguent Gallæ*, U. S.,) for piles. Dose, of powder, 10 to 20 grs.; of the decoction, f℥ij. The tincture (*Tinct. Gallæ*, U. S.) is chiefly used for a test.

The *syrup* is used in chronic diarrhœa.

Kino, U. S. — An extract, or an inspissated juice of certain trees. Several varieties are noticed: 1. East India or Amboyna, from *Pterocarpus marsupium;* 2. African — supposed to be the product of the *Pterocarpus erinaceus*, of Senegal; 3. Jamaica or West India—derived from the *Coccoloba uvifera;* 4. Botany Bay, — the concrete juice of the *Eucalyptus resinifera;* 5. Caraccas.—The one found in our markets is the Amboyna or East India. It comes in small, irregular, angular fragments, of a dark reddish-brown colour, shining fracture, no odour, but a very astringent taste. Soluble in water and alcohol. Active principle, that variety of tannic acid which affords a greenish-black precipitate with the persalts of iron.

Uses. — One of the most used, internally, of all the astringents;

employed frequently with chalk and laudanum in diarrhœa and disentery, not attended with inflammation; also in passive hemorrhages, leucorrhœa, and diabetes. Dose of powder, 10 to 30 grs.; of the infusion (ʒij to f ʒvj water), f ʒss.; of the tincture (*Tinct. Kino*, U. S.) f ʒss. to f ʒij. Kino is used externally, as an injection in gonorrhœa, leucorrhœa, and hemorrhages; also for indolent ulcers.

Catechu, U. S.—Extract of the *Acacia catechu*, a thorny tree growing in Hindostan. Procured by making a decoction of the wood, and then evaporating to a proper consistence. Formerly called *Terra Japonica*, from its supposed earthy origin. There are several varieties of Catechu, one of which is derived from the *Betel nut*, and another, called *cutch*, or *Gambir*, from the *Uncaria gambir* of Sumatra.

Fig. 343.

Prop.—Irregular masses of various sizes; colour, externally, rusty brown, lighter within; taste, bitter and astringent; active ingredient, the same variety of tannin as is found in kino,—which it resembles very much in all its properties. It also contains a principle called *Catechuic acid*.

Uses.—Same as kino. Dose of powder, 10 to 30 grains.

The compound infusion (*Infusum Catechu Compositum*, U. S.) contains ℥ss of catechu, ʒj of cinnamon, and Oj of boiling water; it is used in bowel-affections; dose f℥ss–j. The *tincture* is preferable to the tincture of kino, in consequence of not gelatinizing; dose, fʒj–ij. *Troches* of catechu are employed for relaxed uvula.

Rhatany. (*Krameria*, U. S.)—Root of the *Krameria triandra*, a small shrub growing in Peru and Brazil. The root is branching, and, as found in the shops, is in pieces of various sizes, from the thickness of a quill upwards; colour externally, dark reddish-brown; rather lighter within; taste, bitter, astringent, and sweetish; active principle, tannic acid, which resides most in the cortical portion;—imparts its virtues to water and alcohol.

Uses.—Same as those of kino; a strong and good astringent. The external application is very useful in *fissure of the anus*,—the satu-

rated infusion, made by displacement, or the solution of the extract being used; likewise as an injection in leucorrhœa and gonorrhœa. Dose of powder, 20 to 30 grs.; of the infusion (*Infusum Krameriæ*, U. S.), best made by displacement (℥j to Oj water), f℥j to f℥ij; of the tincture (*Tinct. Krameriæ*, U. S.), fʒj to fʒij; of the extract (*Extractum Krameriæ*, U. S.), made by evaporating the cold infusion obtained by percolation, 10 to 15 grs. There is also a *syrup;* dose fʒj–iv.

Logwood. (*Hæmatoxylon*, U. S.)—Wood of the *Hæmatoxylon Campechianum*, a large tree growing in Mexico, and other parts of tropical America. It is imported in the form of billets, several feet long; has a dark-purplish colour externally, and a bright-red hue internally. It is much used as a dyewood; kept in the shops in the form of raspings; odour, slight; taste, sweetish and astringent; contains a peculiar colouring principle called *hematin* or *hæmatoxylin;* also some tannin.

Uses.—A mild astringent; useful in the bowel-affections of children. Given in decoction and extract; dose of former (*Decoctum Hæmatoxyli*, U. S.), f℥ij; of the latter (*Extractum Hæmatoxyli*, U. S.), 10 to 30 grs.

The most important indigenous astringents are the *Geranium, Blackberry root, Pipsissewa*, and *Uva Ursi.*

Cranésbill. (*Geranium*, U. S.)—Rhizoma of the *Geranium maculatum*, a small perennial plant growing in moist, shady woods; often called *crowfoot*, from the shape of the leaf. The root is horizontal, about a quarter of an inch thick, and furnished with short fibres; colour, externally, brownish; lighter within; no odour; taste, astringent. Virtues depend on tannic acid, and are extracted by water and alcohol.

Uses.—An excellent simple astringent; employed much in domestic practice, particularly in cases of children, to whom it may be given boiled in milk. Dose of powder, 20 to 30 grs.; of the decoction, or infusion, f℥j to f℥ij.

Blackberry root. (*Rubus villosus*, U. S.), Dewberry root. (*Rubus trivialis*, U. S.)—These two roots are identical in medical properties and uses. They occur in pieces of various lengths, of a brownish colour, covered with a thin bark, which abounds most in the active principle, tannic acid.

Uses.—An excellent domestic astringent, much employed in chronic diarrhœas and dysentery; also in the latter stages of cholera infantum. Dose of powder, 20 to 30 grs.; best given in decoction, made by boiling ℥j of the smaller roots in a pint and a half of water, down to a pint; dose, f℥ij. The *fruit* is slightly astringent and an agreeable demulcent.

Pipsissewa. (*Chimaphila*, U. S.)—Leaves of the *Chimaphila umbellata*, sometimes called *Winter-green*, a small evergreen plant, indigenous in both continents. It has a creeping root, which sends up

several erect stems, from four to eight inches high. The leaves are about an inch and a half long, serrated, of a green colour. When bruised, and in the fresh state, they emit an aromatic odour. They retain their green colour, if well dried. Taste, bitter, astringent, and aromatic; water and alcohol extract its virtues, which depend on tannin and a bitter extractive.

Uses.—Chiefly as a mild alterative tonic in scrofulous complaints, and in diseases of the urinary organs; also, in dropsy, attended with dyspepsia and debility. It is best given in the form of decoction and extract. Doses of the former (*Decoctum Chimaphilæ*, U. S.), f℥iv, several times a day; of the latter, 20 to 30 grs. An excellent mode of administering pipsissewa is in the form of *beer*, made by adding molasses, ginger, and yeast to the decoction. A good *infusion* is obtained by displacement.

Uva Ursi, U. S.—Leaves of the *Arctostaphylos Uva Ursi*, or *bearberry*, a small, trailing, evergreen shrub, growing in the northern parts of both continents. The leaves are obovate, about half an inch in length, thick and entire, a good deal resembling the box leaves. They are apt to be adulterated with the leaves of the red whortleberry. No odour when fresh, but acquire the smell of hay by drying; *taste*, bitter, astringent, and sweetish; virtues are yielded to alcohol and water, and depend on tannin and a bitter extractive.

Uses.—Chiefly in disorders of the urinary organs, as catarrh of the bladder, chronic nephritis, diabetes, and incontinence of urine. It is not, however, a certain remedy. Dose of powder, 20 grs. to ʒj, three times a day; of the decoction (*Decoctum Uvæ Ursi*, U. S.),—made by boiling ℥j in Ojss of water, down to Oj, f℥j to f℥ij.

There are a few other vegetable astringents, which are occasionally employed: these are the rind of the Pomegranate (*Granati Fructus Cortex*), the bark and unripe fruit of the Persimmon (*Diospyros*), and the Bistort and Tormentil roots.

The *Rosa Gallica*, or Red rose leaves, is also astringent; the con fection (*Confectio Rosæ*, U. S.), and the compound infusion (*Infusum Rosæ compositum*, U. S.), are officinal. The *confection* is made by incorporating powdered red roses, sugar, honey, and rose-water together. The *compound infusion* contains some dilute sulphuric acid, which renders it slightly refrigerant. The Hundred-leaved Rose (*Rosa centifolia*, U. S.) is not astringent. The latter species furnishes the rose-water (*Aqua Rosæ*, U. S.) of the shops, and the *Unguentum Aquæ Rosæ*, U. S. or *cold cream*.

MINERAL ASTRINGENTS.

Lead. (*Plumbum*, U. S.)—Not employed in medicine, in the metallic state. Its preparations are characterized by the union of astringent with sedative properties; and they may all be regarded as poisonous in over-doses, with the exception of the *sulphate*, which is extremely insoluble. The poisonous impression may be produced in two

modes, either by their being absorbed into the blood, and then acting upon the nervous centres, or by their local irritant action. Lead is very apt, when taken in improper quantities, to cause a series of symptoms called *chronic lead poisoning*, of which the most prominent is *colica Pictonum*, or *painters' colic;* this is attended with loss of appetite, painful and constipated state of the bowels, acute pain about the umbilicus, with a knotty feel of the abdominal muscles, followed by general cramps, convulsions, and death. Another symptom of lead poisoning is paralysis, most generally of the upper extremities, denominated *lead palsy*. These poisonous effects are generally the result of long exposure to the fumes of melted lead, and are usually met with in workmen of lead factories, painters, solderers, &c. The iodide of potassium has lately been recommended as an antidote for chronic lead poisoning. It is believed to dissolve the compounds formed by lead with the tissues, and then to carry the lead with it out of the system by the secretions.

In cases of poisoning from the irritant action of the soluble salts of lead, taken into the stomach in over-doses, some soluble sulphate, as Epsom or Glauber's salt, is to be administered.

Litharge. (*Plumbi Oxidum Semivitreum*, U. S.)—Prepared in the extraction of silver from the argentiferous galena. It is in the form of small semi-vitrified scales, of a flesh colour. They usually contain some carbonic acid. Its chief use is in the preparation of *Lead Plaster* (Emplastrum Plumbi, U. S.), made by boiling together litharge, olive oil, and water; it consists of an *oleo-margarate of lead.* It is the foundation of most of the other plasters.

Carbonate of Lead. (*Plumbi Carbonas*, U. S.)—Called also White Lead. Prepared by exposing lead in thin sheets to the action of the vapours of vinegar, at the temperature of fermenting manure: the vinegar furnishes oxygen and acetic acid, by which a *subacetate* is first formed; and the decomposing manure yields the carbonic acid.

Prop.—A white, heavy, insoluble substance, without smell and taste; one of the most poisonous of the salts of lead; not used as a medicine internally; occasionally applied to excoriated and burnt surfaces; used also in the manufacture of the plaster (*Emplastrum Plumbi Carbonatis*), made to imitate Mahy's Plaster. It is applied to bed-sores. The *ointment* (*Unguentum Plumbi Carbonatis*, U. S.) is used for excoriated and abraded surfaces.

Acetate of Lead. (*Plumbi Acetas*, U. S.)—*Sugar of Lead.*—Prepared by dissolving litharge, or the carbonate, in distilled vinegar, by the aid of heat.

Prop.—A white salt; crystallizes in needle-shaped forms; odour, peculiar; taste, sweetish and astringent; effloresces on exposure; perfectly soluble in pure water, but gives a turbid solution, if there be any carbonic acid present. This may be remedied by a few drops of distilled vinegar. *Incompatibles*, the mineral acids and their soluble salts, the alkalies. alkaline earths, and carbonates, and vegetable astringents.

Uses.—Internally, in hemorrhages, particularly hæmoptysis; also in dysentery, cholera infantum, and in certain disorders of the mucous membrane of the stomach, as in yellow fever, and malignant remittents and intermittents. Dose, gr. ss to gr. ij, every two or three hours, according to circumstances. Used very much as a topical application, particularly in inflammations of the mucous membranes and the skin. The strength of the solution, for mucous membranes, is from gr. ss to gr. ij in f℥j of water; for the sound skin, ℨij dissolved in Oj of water.

Solution of the Subacetate of Lead.—Liquor Plumbi Subacetatis, U. S. — (*Goulard's Extract.*) — Prepared by boiling together equal quantities of sugar of lead and litharge. It is not uniform in its strength, varying with the quantity of lead contained in the preparation. It is a colourless, limpid fluid, having a sweetish, astringent taste. It is decomposed by whatever is incompatible with the acetate, and also by gum and starch. It must be preserved in closely-stopped bottles, to keep it from the carbonic acid of the air.

Uses. — Never internally; externally, diluted, to sprains, bruises, burns, and ulcers, in the proportion of ℨij or ℨiij to the Oj of water.

Lead Water. (*Liquor Plumbi Subacetatis Dilutus*, U. S.) — Contains ℨji to Oj of water. Used for sprains, &c.

Goulard's Cerate. — (*Ceratum Plumbi Subacetatis*, U. S.) — Is made by boiling together Goulard's extract, white wax, olive oil, and camphor; it is an excellent application to abraded surfaces, and to blisters not disposed to heal.

The *iodide* and *nitrate* are also officinal.

Alum. (*Alumen*, U. S.)—Chemically, a double sulphate of alumina and potassa; sometimes found native, though usually made artificially, either from some of the native ores of alum, or by a direct combination of the elements. Some varieties of alum contain sulphate of soda, or sulphate of ammonia, instead of sulphate of potassa.

Prop.—A white crystalline salt, slightly efflorescent, crystallizes in regular octohedrons: taste, sweetish and astringent; very soluble in hot water, which deposits crystals on cooling; reddens litmus; when heated, undergoes the aqueous fusion, and is converted into *dried alum* (*Alumen Exsiccatum*, U. S.) The alum of commerce generally contains some iron as an impurity.

Incompatibles.—The alkalies and their carbonates, lime-water, magnesia and its carbonate, sugar of lead, and tartrate of potassa.

Uses.—A powerful astringent, both general and local. When long used, it is apt to injure the organs of digestion. Large doses occasion irritation of the stomach and bowels, and even inflammation. Given internally, in hemorrhages, particularly of the uterus and lungs; also in colica Pictonum, where it is supposed to do good by a chemical action; formerly used in intermittents. Its nauseant effect is best obviated by combining it with aromatics and opium. Employed externally as an astringent to the throat in inflammation; also to arrest

slight hemorrhages, as in epistaxis, and bleeding from leech-bites; also as an injection in leucorrhœa and chronic diarrhœa, and as a wash to indolent ulcers.

Alum-curd is made by rubbing up alum with the white of an egg; used in conjunctivitis.

Alum-whey is made by boiling ʒij of alum in a pint of milk, and straining; dose, fʒij.—Dose of powdered alum, 5 to 15 grains several times a day; in hemorrhages, the dose must be much increased. Alum is sometimes used as an *emetic.*

The preparations of *copper, zinc,* and *silver* are also astringent; but as they are also *tonic,* they will be spoken of under the latter head.

CLASS II.

TONICS.

Tonics are medicines possessing the power of gradually increasing the tone of the muscular fibre, when relaxed, and the vigour of the body when weakened by disease. Muscular power and tonicity are not always associated; the former may be increased under excitement, where there is actual debility. Though resembling astringents in some of their effects, they do not produce corrugation, except when combined with the astringent principle. They resemble the stimulants in the fact of acting on the system through the medium of the nervous system; but they differ from these in the slowness, as well as the permanency of their effects. Tonics increase the *power,* while mere stimulants only produced increased *action.* Carried to excess, they are productive of debility; and if used in a state of health, they act injuriously, causing an excitation, followed by a proportionate degree of debility. Tonics are particularly indicated in functional disorders of the digestive organs, as dyspepsia, and in the convalescence from acute disorders. *Bitterness* was at one time supposed to be an essential condition to constitute any remedy a tonic; and although it is true that nearly, if not quite all, the vegetable tonics have a bitter taste, still the fact that the mineral tonics are not bitter, would serve to prove that bitterness is not absolutely indispensable in a tonic medicine.

Tonics produce their effects either through the nervous system, upon the tonicity or nutrition; or by a direct impression upon the stomach, enabling it to perform the digestive process better, and so to prepare a more nourishing material for the blood.

They may be conveniently arranged under the two orders of Vegetable and Mineral tonics.

VEGETABLE TONICS.

These may be divided into 1, the Simple or Pure Bitters; 2, Bitters of Peculiar Properties; 3, Stimulant Tonics, 4, Aromatics.

The modification may be caused by some property inherent in the bitter principle, as in the Peruvian bark; or it may be caused by the presence of some stimulating volatile oil, as in serpentaria; or of a sedative principle, as in the case of wild-cherry bark.

I. SIMPLE BITTERS.

These merely increase the appetite and promote digestion, without increasing the circulation. They are especially useful in dyspepsia and in convalescence.

QUASSIA, U. S.—Wood of the *Quassia amara*, and *Simaruba excelsa*, trees growing in South America and Jamaica; the former is not, however, now in use. Imported in billets, which are nearly white, very light in texture, no odour, and a pure, intensely bitter taste. Kept in the shops in the form of chips or raspings. Contains a peculiar bitter principle called *quassin*. Cold water and alcohol extract its virtues.

Uses.—A pure bitter tonic; does not excite the system; applicable in simple dyspepsia, and in convalescence from acute disorders. Used in South America in the treatment of remittent fever.

Dose of powder, 20 grains to ʒj; of the infusion (*Infusum Quassiæ*, U. S.), made with ʒij to Oj of cold water, f℥ij; of the extract (*Extractum Quassiæ*, U. S.), gr. ij to gr. v; of the tincture (*Tinctura Quassiæ*, U. S.), fʒj to fʒij.

Simaruba,—the bark of the *Simaruba officinalis* possesses properties similar to those of quassia, and may be substituted for it.

COLUMBO.—(*Colomba*, U. S.)—Root of the *Cocculus palmatus* (Fig. 344), a climbing plant, growing in Mozambique. The root is

Fig. 344.

perennial, consisting of a main body and numerous offsets. The root, when dug up by the natives, is sliced transversely, and dried. Found

in the shops in circular or oval disks,[5,6] from half an inch to two inches in diameter, and from a quarter to three quarters of an inch in thickness. The epidermis is wrinkled, and of a brownish colour; beneath this is a yellow cortical portion, and within this, the shrunken, whitish, medullary part. It is liable to be attacked by worms, from the starch which it contains. Odour, slightly aromatic; taste, bitter and mucilaginous. Should not be kept in the state of powder, from its liability to attract moisture. Water and alcohol attract its active properties, which depend on a peculiar principle called *colombin*.

Prop.—A mild and excellent tonic; a good remedy in simple dyspepsia, in the sick stomach of pregnancy, and in convalescence; also in the declining stages of dysentery and diarrhœa. Often given with purgatives and aromatics.

Dose of powder, 10 to 20 grains; of the infusion (*Infusum Colombæ*, (U. S.), made with ℥ss to Oj of cold water, f℥j to f℥ij · of the tincture, (*Tinc. Colombæ*, U. S.), fʒj f℥ij.

Fig. 345.

GENTIAN. (*Gentiana*, U. S.)—Root of the *Gentiana lutea*, a perennial plant (Fig. 345), from the mountainous regions of Southern Europe. It comes in pieces of considerable length, sometimes sliced longitudinally, twisted and much wrinkled externally, and of a reddish-brown colour; yellowish within; of a spongy texture; odour, feeble, and somewhat peculiar; taste, very bitter and sweetish; colour of powder, yellowish. Water and alcohol extract its virtues, which depend chiefly on a peculiar crystalline bitter principle called *gentianin*.

Prop.—A pure simple bitter, much employed in dyspepsia, particularly in the form of infusion, made with senna, or rhubarb, and ginger.

Its powder is often combined with iron and purgatives. Gentian is slightly stimulant.

Dose of powder, 10 to 40 grains; of the infusion, made with ℨj to Oj of cold or hot water, fℨij. The compound infusion (*Infusum Gentianæ Compositum*, U. S.), contains orange-peel, coriander seeds, and a little dilute alcohol. The tincture (*Tinctura Gentianæ Composita*, U. S.), contains cardamom seed and orange-peel, and is one of the best of the bitter tinctures; dose f℥j to f℥ij. The extract (*Extractum Gentianæ*, U. S.) is used in the dose of 5 to 30 grains.

White Gentian—the root of *Gentiana purpurea*—is occasionally seen in the markets.

The *American Columbo* (*Frasera*, U. S.) — root of the *Frasera Walteri* — is an indigenous Gentian, growing west of the Alleghany Mountains. Its properties, &c., resemble those of Gentian.

Gold Thread. (*Coptis*, U. S.)—Root of the *Coptis trifolia*, a small, evergreen, herbaceous plant, growing in New England. The plant much resembles a strawberry vine, and has a thin interlaced root, of a golden-yellow colour. In its general properties it strongly resembles quassia; its virtue depends on a bitter extractive. Best given in infusion, made with ℨss to Oj of water; used sometimes as a wash in aphthous sore mouths.

The *Sabbatia angularis*, or *American centaury* (*Sabbatia*, U. S.), is another excellent indigenous tonic, having properties resembling those of the above-named simple bitters. It is generally used in the form of infusion.

Thoroughwort — Boneset. (*Eupatorium*, U. S.) — The herb *Eupatorium perfoliatum*,—an indigenous perennial, growing in moist places, distinguished by the perfoliate character of its leaves, each pair of which are at right angles to those immediately above and below. It has a faint odour, and a strong, bitter taste. Hot water extracts its virtues, which are believed to reside in a bitter principle. The cold infusion acts as a mild, pleasant tonic; the hot infusion as a diaphoretic, or even as an emetic.

II. BITTERS OF MODIFIED PROPERTIES.

Peruvian Bark. (*Cinchona*, U. S.)—The genus *Cinchona* of the former botanists, comprised as many as fifty distinct species; Professor Lindley mentions twenty-six species, most of which are well known. Of these the most important, as affording most of the bark of commerce, are the *C. Condaminea*, *C. micrantha*, *C. cordifolia*, and *C. Calisaya*. The genuine cinchona trees are exclusively found within the geographical limits of La Paz, about 20° of south latitude, and Santa Martha, about 11° of north latitude. They inhabit the mountainous regions of the Andes, usually about 6000 feet above the level of the sea. The several localities which furnish the bark are the following, in their order of discovery:—Loxa, Sta. Fe de Bogota,

Huanuco, La Paz, and Sta. Martha. Of these, Bogota and Sta. Martha furnish the *Carthagena barks;* the others furnish the *officinal barks.* The name *Cinchona* was given to the genus from the circumstance that the Countess of Cinchon was cured of intermittent fever by the use of the bark. It was also named *Jesuits' bark* and *Jesuits' powder,* from its having been used by the Jesuits as a secret remedy. All the different species of the Cinchona have their own peculiar botanical

Fig. 346.

characteristics: they resemble each other, however, in their general features: thus they all have opposite leaves, set upon short petioles; the flowers are at the extremities of the branches, and of a white or rose colour. Fig. 346 represents a branch of the *C. Condaminea.*

There are only three varieties of genuine Peruvian bark recognised by the pharmacopœias; these are the *pale,* the *yellow,* and the *red.*

Pale Bark (*Cinchona pallida,* U. S.)—Called also *Loxa* or *Crown bark,* and by the French, *gray bark.* It includes the commercial varieties of *Loxa,* and *Lima* or *Huanuco* barks; and is the product of the *C. Condaminea,* and the *C. micrantha.* It comes only in quills, which are from half a foot to a foot long, from two lines to an inch in diameter; the epidermis is marked by numerous transverse

cracks; colour of epidermis, gray, though often diversified; internal colour, cinnamon; fracture, smooth; colour of powder, lighter than the others; taste, bitter and astringent, but less bitter than the others.

Yellow bark (*Cinchona flava*, U. S.)—Called also *royal yellow* and *Calisaya* bark. The species which yields it has been ascertained by Weddell to be the *C. Calisaya*. It comes in quills and flat pieces; the former are from three inches to a foot in length, and from a quarter of an inch to two inches in diameter; epidermis, brownish, marked by longitudinal wrinkles and transverse fissures; in flat pieces epidermis wanting; texture fibrous; fracture splintery, exhibiting minute spiculæ; colour of powder, yellow-orange; taste, bitter and nauseous; odour, tan-like; relative value superior to the others, as it abounds most in quinia.

Red Bark (*Cinchona rubra*, U. S.).—Supposed to be derived from the larger branches and trunk of the same tree which yields the pale bark, but its origin is unsettled; size of quills, half an inch to two inches in diameter, and two to twelve inches long; flat pieces are large and thick; external colour reddish-brown, with a very rough epidermis, which occasionally exhibits warts upon it; colour of powder, reddish; taste, bitter.

The *pale bark* contains most cinchonia, the *yellow* most quinia, and the *red* about an equal portion of both alkalies.

The varieties of bark called *Carthagena barks* are much inferior to those just described. They are all shipped from the northern or Atlantic ports of South America.

The classification of the barks, based upon their colour, is rejected by some recent writers, as the colour of the same barks is said to vary, under different circumstances. Pereira arranges them in geographical order, placing the more valuable barks of Bolivia (which furnishes almost exclusively the yellow barks), in one class; those of Peru, (chiefly pale), in a second; those of Ecuador, (both red and pale), in a third; and the less valuable barks of the north, in a fourth class, under the title of New Grenada barks.

The more important active principles, which have been obtained from Cinchona barks, are three *alkaloids*, *quinia*, *cinchonia*, and *quinidia;* which exist chiefly in combination with *kinic* acid. A peculiar astringent acid, called *cincho-tannic acid*, (resembling the tannic acid of catechu), a colouring acid, called *red cinchonic*, and another inert acid, called *kinovic* acid, have also been found. Bark contains also volatile oil, starch, gum, and other vegetable principles.

Quinia is prepared by macerating Calisaya bark in water, acidulated with muriatic acid; this acid forms the soluble muriate of quinia; filter, and add lime, which throws down the quinia, chloride of calcium remaining in solution; next add boiling alcohol, which takes up the quinia, which may then be decolorized by animal charcoal, and separated by evaporation. It occurs in a white flocculent powder; nearly insoluble in water; very soluble in boiling alcohol, ether, and

volatile oils; unites with acids to form salts, of which the most important is the officinal *sulphate.*

Cinchonia is a white crystalline substance, with general properties resembling those of quinia; insoluble in ether.

Quinidia is found in many of the genuine barks; and also largely in some that contain but little quinia. It has not been much used, but is said to resemble quinia and cinchonia in its effects.

Incompatibles.—The alkalies, alkaline earths, acetate of lead, and tannic acid.

Physiological effects.—A tonic in small doses, and in large doses febrifuge; the latter effect is peculiar, and is not dependent upon its tonic properties. In full doses, apt to occasion oppression of the stomach, nausea, and purging; it also acts upon the cerebro-spinal system; as evinced by the tension of the head, ringing of the ears, and occasional deafness.

Uses.—As a mere tonic, it is inferior to the simple bitters in dyspepsia, but applicable in exhausting stages of disease, particularly in suppurations, also in typhoid complaints, in neuralgia, and in rheumatism. Its most important use is in miasmatic diseases, especially intermittent and remittent fever; believed to do good in these affections through the agency of the nervous system.

Cinchona is given in powder, infusion, decoction, tincture, and extract. Most powerful in substance, but apt to disagree with the stomach, and offensive on account of its bulk; dose ʒj, repeated so as to give ℥j to ℥ij in the intermission; its efficacy is increased by combining it with serpentaria. Powdered bark sometimes used externally, in the form of quilted jackets—applied to children. Dose of the *infusion* (*Infusum Cinchonæ Flavæ,* U. S.), (℥j to Oj boiling water) f℥ij. Dose of the *decoction* (*Decoctum Cinchonæ Flavæ,* U. S.), the same. The cold infusion (*Infus. Cinch. Compos.,* U. S.), is preferable, made with cold water, acidulated with sulphuric acid, which more completely exhausts the virtues of the bark, and gives a clear infusion. Dose of *tincture* (*Tinctura Cinchonæ,* U. S.), fʒj to fʒiv. *Huxham's tincture* (*Tinct. Cinch. Composita,* U. S.), contains also serpentaria and other ingredients; dose, the same. Dose of extract, 10 to 30 grs.

Sulphate of Quinia.—Chemically a *disulphate;* made by adding dilute sulphuric acid to quinia, and crystallizing. Occurs in light, feathery, white crystals, without odour; taste bitter; soluble in boiling water and alcohol, and the dilute acids; cold water freely dissolves it by the aid of sulphuric acid; colour of the solution, opalescent. It is apt to be adulterated, which may be detected if with a mineral substance, as sulphate of lime, by a residue being left on exposing it to a high heat; gum, by its greater solubility; starch, by iodine, &c. The term *quinoidine* is applied to an amorphous residuum left in the mother waters out of which sulphate of quinia has been crystallized. It has febrifuge virtues, but is less than half the strength of quinia.

Effects on System.—Generally similar to those of the bark, but sometimes fails to cure intermittents, when the bark will succeed. Dose, as a febrifuge, 16 to 20 grs., equivalent to ʒj of good bark; as a tonic, one to three grains; may be often given by enema; also endermically.

Dose of *sulphates of cinchonia and quinidia*, the same as that of sulphate of quinia.

The best substitutes for Peruvian bark are the *salix*, or willow, which contains a bitter principle, called *salicin;* the barks of the *Horsechestnut*, the *Dogwood*, and the *Nectandra Rodiœi* or *Bibiru;* the latter contains an alkaloid principle called *bibirina*, which is used as a sulphate. Also, the *Liriodendron Tulipifera*, U. S., or *American Tulip-Tree.*

Wild Cherry Bark. (*Prunus Virginiana*, U. S.)—Bark of the *Cerasus Serotina*, an indigenous tree. The bark is taken both from the stem and root; comes in pieces several inches long, slightly curved, usually deprived of the epidermis; has a cinnamon colour; taste, bitter and aromatic, with the flavour of the bitter almond; odour, similar; active properties to water and alcohol; injured by heat. Active principles, hydrocyanic acid and a volatile oil; these do not pre-exist in the plant, but are the result of a reaction between the *amygdalin* and *emulsin* with water.

Effects.—A tonic to the digestive organs, and at the same time sedative to the system. Useful in convalescence, attended with irritability of the stomach; also in the hectic of phthisis.

Best given in *cold infusion* (*Infusum Pruni Virginianœ*, U. S.), made by macerating half an ounce in a pint of cold water 24 hours, or by displacement; dose, fʒij three times a day. There is also a *syrup* (*Syrupus Prun. Virginianœ*, U. S.), which is an excellent preparation; dose, fʒj–iv.

STIMULANT TONICS.

These tonics are more stimulating to the system than the foregoing. They owe their stimulating properties to a volatile oil.

Virginia Snake Root. (*Serpentaria*, U. S.)—Roots of the *Aristolochia serpentaria*, and *A. reticulata*, indigenous herbaceous plants, growing in rich woods. The root is perennial, consisting of numerous long slender fibres, proceeding from a common caudex. As found in the shops, it is in tufts of a brownish colour; has a strong camphorous odour, and a very bitter, acrid, camphorous taste. It yields its virtues to alcohol and water; active ingredients, a volatile oil and a bitter principle.

Effects.—A stimulant tonic; used in low forms of disease; also, stimulates the secretions; employed sometimes as an adjuvant to Peruvian bark.

Dose of powder, 10 to 30 grs.; of the infusion (*Infusum Serpen-*

tariæ, U. S.), (made with ℨss to Oj water) fℨj to fℨij; of the tincture (*Tinctura Serpentariæ*, U. S.), fʒj to fʒij. The decoction and extract are objectionable.

Chamomile. (*Anthemis*, U. S.)—Flowers of the *Anthemis nobilis*, a small, herbaceous perennial, indigenous to Europe, but introduced into the United States. The flowers are both double and single; the latter contain most volatile oil. Imported usually from England. They are about half an inch in diameter, nearly spherical, of a yellowish-white colour; odour, fragrant and aromatic; taste, warm, aromatic, and bitter; virtues depend on a volatile oil and bitter extractive, which are imparted to water and alcohol.

Prop.—A mild, stimulant tonic; useful in convalescence and some forms of dyspepsia; the warm infusion acts as a diaphoretic and emetic. Dose of *cold infusion* (ℨss to Oj), as a tonic, fʒij.

There are several other herbaceous plants, which are mildly stimulant and tonic to the system, as Wormwood (*Absinthium*), Tansy (*Tanacetum*), Horehound (*Marrubium*). These all contain a volatile oil and a bitter principle.

Cascarilla Bark. (*Cascarilla*, U. S.)—Bark of the *Croton Eleutheria*, a tree growing in the West Indies; chiefly imported from Eleutheria, one of the Bahamas; comes in small-sized quills, and in small chips; epidermis is partially detached. Odour aromatic; when thrown upon hot coals it exhales an agreeable odour like musk; taste, bitter and aromatic. Used chiefly as an adjuvant to other tonics. Active ingredients, a volatile oil, and bitter extractive. Dose of powder, 20 to 30 grs.; of the infusion (*Infusum Cascarillæ*, U. S.), made in proportion of ℨj to Oj, fʒij.

Angustura Bark. (*Angustura*, U. S.)—Bark of the *Galipea officinalis*, and probably of *G. Cusparia*, small trees growing in South America. It comes in pieces slightly curved, about a line in thickness, and bevelled at the edges. Colour, yellowish-gray; taste, bitter and aromatic. Virtues depend upon a volatile oil and bitter extractive. A stimulant tonic, not much employed at present; should be carefully distinguished from the *false Angustura bark*, which is derived from the Nux Vomica, and is very poisonous. The *true* bark is always bevelled at the edges, and softens and becomes pliant like leather on being soaked in water. The false variety is intensely bitter to the taste, and gives a red colour when touched with nitric acid, from the *brucia* which it contains. Dose of the *powder*, 10 to 20 grs.; of the *infusion* (*Infusum Angusturæ*, U. S.), fʒj–ij.

Myrrh. (*Myrrha*, U. S.)—An exudation from the *Balsamodendron myrrha* (Fig. 347), a small tree, growing in Arabia and Abyssinia. The juice exudes spontaneously, or by incision. Two commercial varieties —*India* and *Turkey* myrrh: the latter is the finest; comes in masses and tears; of a pale reddish-yellow colour, semi-transparent and brittle; of an aromatic peculiar odour. India myrrh is much inferior,—darker,

softer, and much mixed with a substance called *bdellium*. Myrrh is usually imported from Bombay. It is a gum-resin, associated with a volatile oil; forms a clear tincture with alcohol, and with water a yellow opaque emulsion.

Fig. 347.

The alkalies have the property of uniting with myrrh, and rendering it more soluble in water. Its active properties reside chiefly in the resin.

Effects. — A stimulant tonic, with a tendency at the same time to the lungs and uterus. Most employed in chronic pectoral affections, and in amenorrhœa. Dose of powder, 10 to 30 grains; of the tincture, f℥ss. to f℥j. The *tinctura* (*Tinctura Myrrhæ*, U. S.) is most used as an external application to spongy gums, and to indolent ulcers.

AROMATIC TONICS.

Aromatics are substances possessing an agreeable penetrating odour, and a warm, pleasant taste. These properties depend upon a *volatile oil*, which may be generally separated by distillation with water. They are not true tonics.

The *volatile oils* (*essential* or *distilled oils*) have the odour and taste of the substances from which they are procured; sp. gr. generally less than that of water; almost insoluble in water; soluble in alcohol, ether, and the fixed oils. Their *proximate* composition is into two principles, *stearoptene* and *eleoptene;* the former is solid, the latter liquid. If adulterated with a fixed oil, the fraud may be detected by their leaving a permanent greasy stain upon paper.

All the aromatics possess stimulant properties, though in different degrees. They include the *spices*, which, on account of their agree-

able odour and taste, are much employed as condiments, and also for flavouring or disguising less pleasant medicines. As medicines, they act as grateful stimuli; creating warmth of stomach, obviating nausea, expelling flatulence, and relieving slight colic.

ORANGE PEEL. (*Aurantii Cortex*, U. S.) — The outer rind of the orange (*Citrus aurantium*, or *C. vulgaris*). There are two varieties of orange—the *sweet*, and the *bitter* or *Seville orange;* the rind of the latter only is tonic. As usually prepared by simply peeling the fruit and drying, it is apt to become mouldy; the inner portion should be first rejected. The bitter variety contains a bitter extractive and volatile oil. It is a mild aromatic, chiefly used for flavouring.

The *confection* (*Confectio Aurantii Corticis*, U. S.,) is chiefly employed as a vehicle.

CINNAMON. (*Cinnamomum*, U. S.) — Bark of the *Cinnamomum zeylanicum* (Fig. 348), a native of Ceylon. The bark is stripped from trees of six or seven years old. When dried, it curls up laterally, so as to form quills, which are inserted one within another. The variety

Fig. 348.

called *Cassia* is believed to be the product of the *C. aromaticum*, a native of China, and is sent from Canton.

True cinnamon is known by its colour, the thinness of its bark, the congeries of quills in which it always comes, its splintery fracture, and its sweetish aromatic taste, more pleasant than that of cassia bark, though the best specimens of the latter may be considered nearly as good. There is a volatile oil of cinnamon, and also one of cassia Cinnamon contains some tannic acid, which is the cause of its astrin gency. It is chiefly used as an adjuvant.

Cinnamon Water (*Aqua Cinnamomi*, U. S.), is made by rubbing up the oil of cinnamon with carbonate of magnesia, and then adding water: it is used as a vehicle for other medicines. The *compound tincture* (*Tinctura Cinnamomi Composita*, (U. S.), containing also cardamom and ginger, is used in the dose of fʒj to fʒij.

Pulvis Aromaticus, U. S. (*Aromatic Powder.*) — Contains cinnamon, cardamom, ginger, and nutmeg. It is stimulant and carminative; used chiefly as an adjuvant.

Canella, U. S.—Bark of the *Canella alba*, a tree growing in the West Indies; comes in imperfect quills, of a yellowish-white colour, and a bitter aromatic taste. Its properties are those of a stimulant tonic and aromatic. Not much employed alone; an ingredient in the *hiera picra*, or *Pulvis Aloes et Canella.*

The other spices most employed are *Nutmeg*, *Cloves*, *Mace*, *Black Pepper*, *Cubebs*, and *Allspice.*

Nutmeg. (*Myristica*, U. S.) — Fruit of the *Myristica moschata*, a native of the Moluccas, but grown in Cayenne. They are the kernels of the nut, which is surrounded by a membrane, called *mace.* Nutmegs contain a volatile oil (*Oleum Myristicæ*, U. S.), procured by distillation, and a fixed oil, called *oil of mace*, obtained by expression. Nutmegs are aromatic, and, in large doses, narcotic. Used chiefly as a condiment, and to flavour farinaceous drinks. Mace is employed for the same purpose.

Cloves. (*Caryophyllus*, U. S.)—Unexpanded flowers of the *Caryophyllus aromaticus*, an evergreen, native of the Moluccas. They ought to have a deep brown colour, and an oily aspect.

Cloves are one of the most stimulant aromatics; they depend for their virtue upon a volatile oil (*Oleum Caryophylli*, U. S.), which is rather heavier than water. Dose of powder, 5 to 10 grains; of *infusion* (*Infusum Caryophilli*, U. S.), made with ʒij to the pint, f℥ij; of the volatile oil, 2 or 3 drops.

Black Pepper. (*Piper*, U. S.)—Dried berries of the *Piper nigrum*, a vine, native of the East Indies. The fruit when first ripe is red, but becomes black by drying. When deprived of its outer coating, it constitutes *white pepper.* It contains a peculiar crystalline principle—*piperin*—which, however, is not the active principle; this resides in

the volatile oil. Piperin has been used as an *anti-intermittent;* dose, gr. ij–viij. The fluid extract (*Extractum Piperis Fluidum,* U. S.), has been lately introduced; dose, f℥ss–j.

Black pepper is chiefly employed as a condiment; it is a decided stimulant in large doses. Its excessive use is injurious to the stomach.

CUBEBS. (*Cubeba,* U. S.)—Dried fruit of the *Piper cubeba,* a vine much resembling the last. The cubeb berries are distinguished by being reticulated, and having a short footstalk attached to them. They have an aromatic odour, and a warm camphorous taste; depend for their virtues on a volatile oil, procured by distillation. They have a tendency to act on the kidneys, and in larger quantities to affect the head. As a medicine, its chief use is in affections of the urino-genital organs, particularly gonorrhœa. Dose of powder, ℥ss to ℥j; of the volatile oil (*Oleum cubebæ,* U. S.), 10 to 20 drops. The *fluid extract* (*Extractum Cubebæ Fluidum,* U. S.,) is an excellent preparation; dose, gtt. xx to f℥j. The *tincture* (*Tinctura Cubebæ,* U. S.,) is given in the dose of f℥ss–j.

ALLSPICE. (*Pimenta,* U. S.)—Called also *Jamaica pepper.* Grows in Jamaica; fruit of the *Myrtus pimenta;* called *allspice,* from its combining the flavour of several other spices. Its virtues depend on a volatile oil. Used only as a condiment.

The AROMATIC SEEDS most employed in medicine are the following:—

CARDAMOM (*Cardamomum,* U. S.), from the *Elettaria Cardamomum,* a native of Malabar and the East Indies.

FENNEL SEED (*Fœniculum,* U. S.), from the *Fœniculum vulgare,* a native of the south of Europe, but introduced here.

CORIANDER (*Coriandrum,* U. S.), from *Coriandrum sativum,* a native of Europe, but cultivated here.

CARAWAY (*Carum,* U. S.), from *Carum Carui,* growing in Europe.

ANISE (*Anisum,* U. S.), from *Pimpinella Anisum,* a native of Europe and Africa.

These all contain a volatile oil. They are used, as well as their oils, chiefly as adjuvants, to impart an agreeable flavour to other medicines. The *tincture of Cardamom* (*Tinctura Cardamomi,* U. S.), is an excellent stomachic aromatic for nausea and slight colic; dose, f℥j–ij.

Fennel Water (*Aqua Fœniculi*) is much used as an agreeable vehicle for mixtures.

The following AROMATIC HERBS (*Labiatæ*) are also employed in medicine:

Lavender. (*Lavandula*, U. S.)—The flowering tops of *Lavandula vera*, native of Europe, but grown here. The flowers have a delightful odour, and yield a volatile oil on distillation. The *spirit*, or *lavender-water*, as it is often improperly named (*Spiritus Lavandulæ*, U. S.), is made by distilling the flowers with alcohol; it is a very agreeable perfume. The *compound spirit*, or *lavender compound* (*Spiritus Lavandulæ Compositus*, U. S.), contains spirit of lavender, spirit of rosemary, cinnamon, cloves, nutmeg, and red saunders. It is much employed as a grateful stomachic in sick stomach and mild colics; also to impart flavour; dose f℥j–ij.

Rosemary. (*Rosmarinus*, U. S.)—The flowering tops of *Rosmarinus officinalis;* indigenous in Europe, but grown here. It contains a highly stimulating volatile oil, used in making opodeldoc, and camphorated tincture of soap. The *spirit* (*Spiritus Rosmarini*, U. S.) is used occasionally.

Peppermint. (*Mentha Piperita*, U. S.)—A native of Europe, but naturalized here. The whole herb is used, and is most active when in flower. Its *oil* is occasionally prescribed in doses of gtt. ij–iij, but is more frequently used in the form of *Essence of Peppermint* (*Tinctura Olei Menthæ Piperitæ*, U. S.), made by dissolving f℥ij of the oil in Oj of alcohol. Dose, gtt. v–xx, on a piece of loaf-sugar, to relieve nausea and slight colic. *Peppermint-water* (*Aqua Menthæ Piperitæ*, U. S.), is prepared by rubbing up f℥ss of the oil with ℨj of carbonate of magnesia, and then adding Oij of distilled water, and filtering. It is much used as a vehicle. The fresh herb bruised and applied to the stomach will frequently relieve pain and nausea; it is used chiefly for children.

Spearmint. (*Mentha Viridis*, U. S.)—Is very similar in properties to Peppermint. The *oil*, *essence*, and *water* are made in the same manner as the corresponding preparations of Peppermint, and are used for similar purposes.

Pennyroyal (*Hedeoma*) is similar to the Mints in properties, though rather more stimulating.

Balm (*Melissa*, U. S.), and Marjoram (*Origanum*, U. S.), are also strongly allied in properties to the preceding herbs.

Sage. (*Salvia*, U. S.)—Leaves of *Salvia officinalis*. Contains a volatile oil and some tannic acid, which imparts to it astringent properties. It is chiefly employed in infusion (*sage-tea*) for sore throats. Alum may often advantageously be added.

Partridge-berry. (*Gaultheria*, U. S.)—Leaves of *Gaultheria procumbens*. It contains a very heavy essential oil, of a dark colour, used to impart flavour; an ingredient in the compound syrup of sarsaparilla.

Ginger. (*Zingiber*, U. S.)—Rhizoma of *Zingiber officinale*, a perennial, herbaceous plant, growing in the East and West Indies.

Several varieties are found in the shops. Sometimes the recent root, in a state of vegetation, is sent to the market, constituting *green ginger;* sometimes the root is dug up, scalded to prevent germination, and then dried, constituting common *black ginger;* again, the best pieces are selected, the outer skin removed, so as to give it a white appearance, and imported as *white ginger.* The latter comes from Jamaica.

Colour of the powder, light yellowish-white; odour, powerful and peculiar; taste, strong, aromatic, and biting. It contains a volatile oil, an acrid resin and starch.

It is a grateful stimulant and carminative; used to expel flatus from the bowels; employed also as an adjuvant to the bitter tonics, in cases of dyspepsia. It is apt to be much deteriorated by age.

Given in powder, infusion, tincture and syrup. Dose of powder, 10 to 30 grs.; of the infusion (*Infusum Zingiberis*, U. S.), made with f℥ss to the pint, fʒij; of the tincture (*Tinctura Zingiberis*, U. S.), fʒj. The *syrup* (*Syrupus Zingiberis*, U. S.) is used generally for flavouring. Externally applied, ginger acts as a rubefacient.

Sweet Flag. (*Calamus*, U. S.)—Rhizoma of *Acorus calamus*, a plant growing in marshes. Its effects on the system, and uses are very similar to those of ginger. It contains a volatile oil and extractive.

MINERAL TONICS.

Iron. (*Ferrum*, U. S.)—The most important of all the mineral tonics; a constituent of many organized beings, and found in the red globules of the blood. The preparations of iron, called *chalybeates*, combine tonic with astringent properties; they increase the appetite, promote digestion, and exalt the general functions of life. Under its use, the red corpuscles of the blood become much increased, giving rise to a tendency to plethora. Its influence over the nervous system appears to be rather secondary. The chalybeates prove most useful in dyspepsia with constipation, not accompanied by inflammation of the stomach; also in chronic debility of females associated with amenorrhœa; in some nervous affections; and especially in anemia.

Metallic iron is probably inert upon the system; but when swallowed in that state, it is apt to become converted into an oxide or salt in the stomach and bowels, and to disengage hydrogen gas, which causes unpleasant eructations. Iron filings (*Ramenta Ferri*, U. S.), which are sometimes used, should be previously purified by means of a magnet. Dose, gr. v–xx.

Squamæ Ferri (*Scales of Iron*).—Obtained by hammering red-hot iron; consist chemically of the protoxide and peroxide. Dose, 5 to 20 grains.

Ferri Pulvis, U. S. (*Iron by Hydrogen.*)—Made by passing hydrogen over the oxide heated to redness: it is an efficient preparation. Dose, gr. j–v.

Rubigo Ferri (*Rust of Iron*).—Formerly called prepared carbonate of iron; prepared by exposing fine iron wire to air and moisture, then reducing to a fine powder by levigation and elutriation. It consists of the protocarbonate and the sesquioxide. Colour, red; taste, styptic; insoluble in water. Dose, gr. v–xx.

Ferri Subcarbonas, U. S. (*Subcarbonate of Iron*).—Formerly named *Precipitated Carbonate;* made by mixing together the solution of the carbonate of soda, and sulphate of iron. When first prepared the colour is greenish-black, which soon changes into a brownish-red, from the absorption of oxygen; it then consists chiefly of the sesquioxide. It has a styptic taste; no odour; is insoluble in pure water. It is one of the best chalybeates; is well borne by the stomach, and no danger from an over-dose; much used in neuralgia. Dose, 5 to 30 grains.

Pilulæ Ferri Carbonatis, U. S. (*Vallet's Ferruginous Pills.*)—Prepared as the subcarbonate, with the addition of sugar and honey, which prevents the absorption of oxygen; colour, bluish. Dose, 2 to 10 grains, three times a day.

Mistura Ferri Composita, U. S. (made to imitate *Griffith's Anti-hectic Mixture.*)—Prepared by mixing together solutions of carbonate of potash and sulphate of iron, with myrrh and spirits of lavender. Used chiefly in amenorrhœa with dyspepsia.

Ferri Sulphas, U. S. (*Sulphate of Iron—Green Vitriol*, or *Copperas.*)—Prepared by action of dilute sulphuric acid on pure iron wire. Colour, pale green; crystals efflorescent, soluble; taste, styptic; fuses when heated. *Incompatibles*—alkalies, alkaline earths, and earths with their carbonates, and those soluble salts whose acids form soluble salts with iron, and whose bases form insoluble sulphates; also tannin. It is one of the most astringent of the chalybeates, also the most irritant. Applicable when small doses are required; best in pill of the effloresced salt. Dose of the crystallized, 1 to 5 grains; of the dried, gr. ss. to grs. ij.

Tinctura Ferri Chloridi, U. S. (*Muriated Tincture of Iron.*)—Made by the action of muriatic acid on the subcarbonate, and then adding alcohol. Colour, reddish-brown; odour, ethereal; taste, sour and styptic. Used in affections of the urino-genital organs. An excellent chalybeate. Dose, gtt. v–xx. Used externally as a stimulant.

Ferri et Potassæ Tartras, U. S. (*Tartrate of Iron and Potassa*)—Prepared by adding cream of tartar in water to the freshly-prepared hydrated oxide of iron at the temperature of 140°; filter, evaporate to the consistence of syrup, and then spread upon glass or porcelain, so as to dry in the form of scales. *Prop.*—In transparent scales of a ruby-red colour, wholly soluble in water; the basis of the old *wines of iron.* It is an admirable chalybeate: dose, gr. x–xx.

Ferri Phosphas, U. S. (*Phosphate of Iron.*)—Prepared by the ac-

tion of phosphate of soda on sulphate of iron. It is insoluble in water; of a bluish colour, and changes by exposure. Dose, gr. x–xx.

Ferri Ferrocyanuretum, U. S. (*Ferrocyanuret of Iron, Prussian Blue.*)—Prepared by the action of the persulphate of iron on ferrocyanuret of potassium. It is of a deep blue colour, and insoluble. It is tonic and sedative. Used in nervous affections, and in intermittents. Dose, gr. v–xx.

Ferri Oxidum Hydratum, U. S. (*Hydrated (sesqui) Oxide of Iron.*)—Prepared by the action of solution of ammonia on the solution of the per (sesqui) sulphate of iron (made by adding sulphuric and nitric acids to a solution of the sulphate,) and washing the precipitate with water. It should be kept in close bottles under water. *Use.*—Chiefly as the antidote for arsenic, in which case it must be given in large doses. Its remedial effects are similar to those of the carbonates.

Ferrum Ammoniatum, U. S. (*Ammoniated Iron.*)—Prepared by adding muriatic acid to subcarbonate of iron, and then add muriate of ammonia, and evaporate to dryness. It is of an orange colour, soluble in water. Used chiefly in nervous disorders. Dose, gr. iv–x.

Ferri Iodidum, U. S. (*Iodide of Iron.*)—Prepared by putting iodine and iron filings together in water, in a glass or porcelain vessel, and gently heating; then filter and evaporate. As it is extremely deliquescent, it is better to employ the solution (*Liquor Ferri Iodidi*, U. S.), made by the addition of sugar and water; the sugar preventing its decomposition. *Prop.*—An excellent preparation in scrofula and the cachexiæ. Dose gr. i–ij; of the *solution*, gtt. x–xx.

Ferri Citras, U. S. (*Citrate of Iron.*)—Made by adding citric acid in solution to the solution of the hydrated oxide, and then treat as directed for tartrate of iron and potassa. It occurs in garnet-red flakes, soluble in water. It is a mild, though certain chalybeate. Dose, gr. iij–v.

Liquor Ferri Nitratis, U. S. (*Solution of Nitrate (sesquinitrate) of Iron.*)—Prepared by the action of dilute nitric acid on iron wire. It is the most astringent of the chalybeates, and is used in chronic diarrhœas. Dose, gtt. x–xx.

The *Lactate* is also occasionally used.

Copper. (*Cuprum*, U. S.)—Though probably inert in the metallic state, yet being easily acted upon by the acids of the stomach, it may prove poisonous when swallowed in that state. Poisoning may also result from eating articles cooked in copper vessels. The preparations of copper act as tonics in very small doses, with an especial tendency to the nervous system. Larger doses occasion irritation and inflammation of the stomach. As *poisons*, they act both as local irritants and also upon the nervous centres. The best antidote is albumen; iron filings and ferrocyanide of potassium are partial antidotes.

Cupri Sulphas, U. S. (*Sulphate of Copper — Blue Vitriol.*)—Prepared by the action of sulphuric acid on metallic copper. Occurs

in large, prismatic, blue crystals; efflorescent on exposure; soluble in water; taste, very styptic; fuses when heated; incompatibles, the same as of iron.

Effects on System. — Small doses are astringent and tonic; larger doses vomit; still larger are poisonous. The best antidote is albumen.

Used as a tonic in obstinate ague; as an astringent in chronic dysentery and diarrhœa, and in chronic bronchitis; also, in epilepsy, chorea, and hysteria. Dose, ¼ grain, two or three times a day; as an emetic, gr. v–x. Useful as an external application, in solution, to spongy granulations of ulcers, and inflamed conditions of mucous membranes, particularly of the eye.

Cuprum Ammoniatum, U. S. (*Ammoniated Copper.*) — Made by rubbing up carbonate of ammonia with sulphate of copper; colour, dark blue. Supposed to have a special tendency to the nervous system; hence used in epilepsia, chorea, &c. Dose, gr. ss–iij, twice a day.

ZINC. (*Zincum*, U. S.) — Its preparations are useful in nervous disorders.

Zinci Sulphas, U. S. (*Sulphate of Zinc — White Vitriol.*)—Made by action of dilute sulphuric acid on metallic zinc. Crystals, needle-shaped prisms, white; taste, styptic; soluble in water. Incompatibles, the same as for sulphate of copper.

Effects.—Tonic and astringent; used chiefly in chorea and epilepsy. Dose, two to three grains. In large doses, as 10 to 20 grs., emetic. The *solution* an excellent application to inflamed mucous membranes; strength of the solution gr. j or grs. ij to f℥j of water. It is sometimes employed in combination with the acetate of lead.

Zinci Acetas, U. S. (*Acetate of Zinc.*)—Made by adding metallic zinc to a solution of acetate of lead. It is in white crystals, soluble in water; *used*, chiefly externally, as the sulphate.

Zinci Oxidum, U. S. (*Oxide of Zinc.*)—Prepared by heating the precipitated carbonate. A white insoluble powder, used internally in epilepsy, dose, gr. iij–v; externally as a dusting powder to excoriated surfaces, and in the form of ointment.

Calamina Præparata, U. S. (*Prepared Calamine — Native Carbonate of Zinc.*) — Used in the form of a cerate (*Turner's cerate*) — a good application to excoriated surfaces and certain cutaneous eruptions.

Sulphate of Cadmium has been lately introduced as an external application for the eye; it resembles sulphate of zinc.

SILVER. (*Argentum*, U. S.)—ARGENTI NITRAS, U. S. (*Nitrate of Silver — Lunar Caustic.* — Prepared by the action of nitric acid on silver; evaporating, fusing, and running into moulds. Colour, nearly white; very soluble; taste styptic and harsh. Incompatibles, the same as for iron,—also common salt.

Effects. — Small doses are tonic; larger, corrosive and poisonous

Best antidote is common salt. Its long use is apt to occasion a discoloration of the skin. Most used in epilepsy and chorea; also in irritable conditions of the stomach; and as an astringent in dysentery and diarrhœa. Dose, gr. ss to gr. ij, given in pill. Its solution is very valuable as a topical application to indolent ulcers, and to inflamed mucous membranes, as of the eye, nose, urethra, vagina, and rectum; strength of the solution from gr. ss to gr. x to f℥j of distilled water;—also for the throat and tonsils, either applied in strong solution, or in the solid form.

Argenti Oxidum, U. S. (*Oxide of Silver.*)—Is made by action of potassa on the nitrate; *used* as the nitrate.

Bismuth, (*Bismuthum*, U. S.)—Bismuthi Subnitras, U. S. (*Subnitrate of Bismuth—Magistery of Bismuth.*)—Made by the action of nitric acid on bismuth, and then throwing the resulting nitrate into water, which throws down the subnitrate. A white powder, without taste or smell. Used chiefly in disorders of the stomach, connected with diseased innervation, as gastrodynia; also in diarrhœa. Dose, ten to twenty grains. Apt to blacken the stools.

THE MINERAL ACIDS.

Usually classed among the tonics.

Acidum Sulphuricum, U. S. (*Sulphuric Acid.*)—Employed only in medicine in a state of solution. Acts as a tonic, astringent, and restorative to the blood; used in low forms of fever, in diarrhœa, and to check excessive perspiration. The dilute acid of the Phar. contains f℥j of the concentrated acid, to f℥xiij of water; dose, 10 to 30 drops, in a wineglass of water. The *elixir vitriol*, or aromatic sulphuric acid (*Acidum Sulphuricum Aromaticum*, U. S.), contains ginger and cinnamon; it is much used in the hectic fever of phthisis, and in convalescence from acute disorders. Dose, the same.

There is also an *ointment*.

Acidum Nitricum, U. S. (*Nitric Acid.*)—Effects resemble those of sulphuric; never used in its pure state; two kinds kept in the shops, the *nitric*, which is colourless, and the *nitrous*, which is reddish. Used as a restorative to the blood in low forms of fever, and to correct alkalinity in the urine in phosphatic lithiasis. Dose 2 to 10 drops, according to its strength. A strong solution is used externally to indolent ulcers. *Hope's mixture* consists of nitric acid, laudanum, and camphor water; used in dysentery, &c.

Acidum Muriaticum, U. S. (*Muriatic Acid.*)—Colourless when pure; used in a dilute form in low forms of fever, especially in typhus fever. Dose 5 to 20 drops, in a wineglass of water. Used also as a gargle in scarlet fever.

Acidum Nitro-Muriaticum, U. S. (*Nitro-Muriatic Acid.*)—

Made by mixing one part of nitric with two of muriatic acid; mutual decomposition ensues, by which nitrous acid fumes are given off, and chlorine remains dissolved in water. It is thought to have an especial tendency to the liver, and is given in hepatic diseases; also in secondary syphilis. Used likewise as a bath, or foot-bath, in these disorders. — The *solution of chlorine* sometimes used in bronchitis; also the vapour of chlorine inhaled, but is apt to occasion irritation.

Under the head of Tonics, *Cod-liver Oil* (*Oleum Morrhuæ*, U. S.) may be appropriately placed. It is procured from the fresh liver of the codfish, *Gadus Morrhua*, by pressure, or by spontaneous draining. Two or three varieties are found in the markets, the best of which is of a light-yellow colour, and transparent, and of a peculiar taste and smell. It contains some iodine and bromine, besides the usual fatty principles.

Effects, &c.—When used for some time it increases the function of nutrition; its influence is especially observable in chronic diseases of a wasting character, particularly in phthisis; given in the forming stage of the latter disorder, it has appeared in many cases to have arrested it. It is somewhat liable to disorder the stomach. Dose f℥ss–j, two or three times a day. It is necessary to continue its use for two or three months.

CLASS III.

ARTERIAL STIMULANTS.

These are substances which increase the activity of the circulation, as a primary effect, though their operation is also generally extended to other parts of the system. They are sometimes named *excitants*, and, from their rapidity of action, *diffusible stimulants*. Many other articles, classed elsewhere, produce, among their other effects, stimulation of the heart and arteries, as opium, alcohol, ether, &c. They differ from *tonics* in their more powerful and rapid action; they do not, as tonics, increase the *power* of the system.

They are indicated in all cases of sudden or great prostration; but they should not be indiscriminately used, from fear of subsequent reaction. As a general rule, inflammation or fever contraindicates their use; but there may be cases in which they will be proper.

Carbonate of Ammonia. (*Ammoniæ Carbonas*, U. S.)—Chemically a *sesquicarbonate;* improperly termed *volatile alkali.* Prepared by subliming together carbonate of lime and sal ammoniac. When first made it is a solid, white, transparent cake; odour, strong and pungent; taste, acrid and alkaline; soluble in water and alcohol;

becomes converted into a bicarbonate on exposure to the air, losing its translucency and some of its activity.

Effects.—A powerful diffusible stimulant, acting chiefly upon the circulation; it has a local tendency to the lungs and skin.

Uses.—Much employed in the sinking stages of fever, or of acute diseases, especially of the lungs; also in atonic gout, and dyspepsia attended with acidity of stomach; externally, to bites of poisonous insects. Dose, 5 grains every hour or two, given in solution with gum and sugar, to obtund its acrimony.

The *Aromatic Spirit of Ammonia* (*Spiritus Ammoniæ Aromaticus*, U. S.), is made by distilling together muriate of ammonia, carbonate of potassa, cloves, cinnamon, lemon-peel, alcohol, and water. It is an agreeable stimulant cordial, used in languor, faintness, and sick stomach. Dose, f ʒss–ij.

The *Spirit of Ammonia* (*Spiritus Ammoniæ*, U. S.), is only a solution of gaseous ammonia in dilute alcohol; it is not much used.

OIL OF TURPENTINE. (*Oleum Terebinthinæ*, U. S.)—Procured from common turpentine, which consists of the volatile oil and resin, by distillation. Called improperly *spirits of turpentine.*

Prop.—A colourless limpid fluid; odour, strong and peculiar; taste, hot, and peculiar; rather lighter than water, with which it is slightly soluble; its proper solvent is boiling alcohol. Chemically, a *hydrocarbon;* but when exposed to the air, absorbs oxygen, which converts part of it into resin.

Effects.—Small doses produce a warming, stimulating effect upon the stomach and the system generally, increasing the action of the heart and arteries. It is absorbed into the circulation, as proved by its being exhaled from the secretions. Apt to act upon the kidneys, sometimes with violence. Large doses act as a cathartic, and anthelmintic.

Uses.—A valuable stimulant, particularly in low forms of fever; more especially in *typhoid fever*, attended with dry tongue, delirium, tympanitis and subsultus. It is believed by some to produce an alterative impression upon the mucous membrane. Also in chronic catarrh, chronic dysentery, chronic nephritis, chronic gout and rheumatism; also in hemorrhages from the lungs and bladder. Dose, from 5 to 20 drops, given in emulsion, or dropped on sugar, and frequently repeated.

PHOSPHORUS is one of the most powerful of the stimulants, but is rarely employed. It appears to have an especial tendency to the genital organs, and is reputed aphrodisiac. It should never be used in substance, but in ethereal solution. Dose, one-twelfth of a grain.

CAYENNE, OR RED PEPPER. (*Capsicum*, U. S.)—The fruit of the *Capsicum annuum*, and other species; a native of the East and West Indies, but cultivated in our gardens. The fruit is in pods, 2 or 3

inches long, of a conical shape; colour, when ripe, bright red, which becomes darker by drying; colour of powder, red. The odour and taste of capsicum are peculiar, and depend on a fixed principle, named *capsicin*, also a pungent oil, and extractive. Alcohol and water extract its active properties.

Effects. — A powerful stimulant, especially irritant to the part to which it is applied.

Uses.—When a powerful local impression is required, as in rousing the action of the stomach; peculiarly applicable in malignant scarlet fever attended with putrid sore throat. A preparation consisting of two tablespoonfuls of powdered capsicum, one teaspoonful of common salt, half a pint of boiling vinegar, and half a pint of boiling water, is much used for this purpose in the West Indies. A saturated infusion may also be applied locally to the throat in gangrenous cases, with great benefit.

Dose of powder, 5 to 10 grains; of infusion (*Infusum Capsici*, U. S.), made with ʒij to Oss water—f℥ss; of the tincture, fʒj to fʒij. The strength of the gargle should be proportioned to the severity of the case.

CLASS IV.

NERVOUS STIMULANTS.

Medicines which stimulate the nervous centres, among their other stimulating operations. As they all probably first enter into the circulation, their impression is first made there.

One of the modes in which deranged nervous action most frequently manifests itself is *spasm*, and from the power of this set of remedies to control it, they have been termed *antispasmodics*. This term, however, is not strictly applicable to them, since spasm depends upon a diversity of pathological conditions, being sometimes produced by an excess of power in the nervous centres, and at others by a deficiency. Sometimes it is caused by congestion, or inflammation; in which cases the nervous stimulants would be inadmissible, but depletion would be required.

They are employed in all disorders connected with nervous derangements of any sort, not accompanied with high arterial action. Thus in hysteria, hooping-cough, spasmodic asthma, insomnolency, &c.

They all possess more or less of a fœtid odour, upon which their peculiar virtues were, at one time, supposed to depend.

Musk. (*Moschus*, U. S.)—Product of the *Moschus moschiferus*, an animal somewhat resembling a deer, inhabiting the mountainous districts of Asia. The musk resides in an oval pod, about two and

a half inches in length, and one and a half in breadth, situated between the prepuce and umbilicus. Musk is a secretion of the lining membrane of this pouch, and is found only in the male, and most abundantly in the adult animal. It is in the form of reddish-brown coarse granules, and, from its very high price, is extremely liable to adulteration. Its chemical composition is very complex: it is inflammable.

Uses. — Musk, when genuine, is one of the most powerful of the antispasmodics. Given in full doses, it excites the circulation, as well as the cerebro-spinal system, producing an exhilarating effect, with occasional vertigo and headache; also slightly hypnotic. It is employed with advantage in retrocedent gout, obstinate singultus, infantile spasms not accompanied with inflammation, &c. Advantageously given to children in enema. Dose, 5 to 15 grs. Given in form of emulsion,—dose, f ʒi to f ʒij; of the *tincture*, gtt. xxx.

CASTOR. (*Castoreum*, U. S.) — A substance strongly resembling musk in its medicinal properties and therapeutical applications. It is the product of the *Castor Fiber*, or beaver, and is contained in two follicles situated near the anus of the animal. It contains a peculiar matter called *Castorin*, and a volatile oil. Dose, gr. x–xx; of the *tincture*. (*Tinct. Castorei*, U. S.), gtt. xxx.

ASSAFŒTIDA, U. S. — A gum-resin — the product of the *Narthex assafœtida*, and possibly of some others. The *N. assafœtida* is an umbelliferous plant, growing in Persia and Affghanistan, having a long, tapering, perennial root, and very long leaves. Assafœtida is obtained by slicing off the top of the root, and collecting the juice as it exudes, which is then kneaded into masses, and packed for market.

At first it is rather soft, but hardens by exposure, which also renders it darker. Colour, externally, reddish-brown; internally, rather lighter, mottled with white tears, and shining; taste, bitter, acrid, and alliaceous; odour, very strong and alliaceous, but more powerful in the fresh juice. It softens by heat, and is inflammable. Chemically, it is a gum-resin, united to some volatile oil. Water dissolves the gum, which forms an emulsion with the resin; alcohol forms a clear, golden tincture.

Uses.—One of the most valuable of the antispasmodics; also stimulant, expectorant, laxative, and emmenagogue. Employed with advantage in hysteria, infantile convulsions, hooping-cough, chronic cough of a nervous character; also as a carminative, along with rhubarb and aloes, in the constipation of old persons, and as an emmenagogue. Advantageously given to children by enema, in which case it will often prove laxative.

Dose of substance, gr. v to x, given in form of pill; — of the emulsion (*Lac assafœtida*), f ʒss to f ʒj;—of the tincture, f ʒss–j.

Assafœtida is sometimes used in the form of a plaster, in chronic swellings.

Valerian. (*Valeriana*, U. S.)—Root of the *Valeriana officinalis*, a perennial plant, indigenous in Europe, growing about two or three feet high. The root consists of a short tuberculated rhizome, from which issue numerous round, tapering fibres, of a yellowish-brown colour externally, and whitish internally. Taste, bitter and acrid; odour, when dry, strong, peculiar, and somewhat aromatic. It depends for its virtues on a yellow volatile oil, separable by distillation, and an acid, named *valerianic acid.*

Uses.—A mild antispasmodic and stimulant. Useful in hemicrania, combined with cinchona; also in slight nervous derangements. Best given in form of *infusion* (*Infusum Valerianæ*, U. S), made with half an ounce of the root to a pint of boiling water; dose f℥i to f℥ij. Dose of the *oil of Valerian*, 3 to 5 drops; — of the *tincture* (*Tinct. Valerianæ*, U. S.), f℥j; — of the *ammoniated tincture* (*Tinct. Valerianæ Ammoniata*, U. S.),—made with the aromatic spirit of ammonia, — f℥ss; of the *fluid extract* (*Extractum Valerianæ Fluidum*, U. S.), gtt. x–xxx.

Garlic. (*Allium*, U. S.) — Is decidedly antispasmodic, especially in cases of children, to whom it may be advantageously applied in the form of cataplasms to the feet, to quiet the nervous irritation to which they are frequently liable in the course of disease. Sometimes employed as a counter-irritant to the spine, in cases of hooping-cough. It is likewise expectorant.

Oil of Amber. (*Oleum Succini*, U. S.)—*Amber* is a fossil resin, the product, probably, of some extinct species of *coniferæ*, found on the shores of the Baltic. It occurs in fragments usually of small size, of a yellowish colour, translucent, without odour, and inflammable. By destructive distillation it yields a volatile oil and *succinic acid.*

The *oil*, as first procured by distilling amber with sand, is thick, and of a very dark colour and empyreumatic smell; when purified by redistillation with water, it constitutes *Oleum Succini Rectificatum*, U. S.; this has a clear amber colour, and a less offensive odour; it is the only preparation used internally.

It is a decided stimulant to both the arterial and nervous systems used chiefly in hooping-cough, infantile convulsions, obstinate hic cough, hysteria, &c.; also as a rubefacient to the spine in infantile convulsions, and hooping-cough; and for rheumatism and palsy. It also increases the secretions, especially the urinary. Dose, gtt. v–xx, in emulsion.

The *Skunk Cabbage* (*Dracontium*, U. S. *Sec.*)— root of *Dracontium fœtidum* (*Symplocarpus fœtidus*), is a powerful nervous stimulant, especially in the fresh state. It deteriorates very much by age,

and is hence not much used in regular practice. It has been employed with benefit in asthma. Dose, gr. x–xx.

Coffee and *Tea* possess decided virtues as nervous stimulants. The excessive use of either, especially of the former, is very apt to induce dyspepsia and its attendant evils. They may be beneficially resorted to as stimulants in nervous headache, and other mild nervous disorders.

CLASS V.

CEREBRAL STIMULANTS.

THIS class of stimulants, termed *Narcotics* by most writers, acts chiefly upon the brain, though at the same time, influencing both the circulation and the spinal nervous system. Like all other stimulants, their primary impression is followed by a proportionate degree of depression, which becomes excessive and dangerous, when the dose has been very large.

Their operation upon the system is usually described as consisting of three stages: 1, that of *stimulation*, which is transient; 2, that of *narcotism* or *sleep*, which is prolonged in proportion to the dose; 3, that of *depression*. The difference of these several stages of action have been ascribed to a supposed difference in their manner of operating; the immediate or stimulant effect being supposed to be due to action upon the nerves, while the narcotic depressing effects were attributed to a slower action, through absorption. They differ very much in their energy over the system, and are, by some, believed to act upon the different parts of the cerebral mass.

In large doses they are poisonous,—death resulting from asphyxia, in consequence of a suspension of the powers of the brain, or rather, of the medulla oblongata.

There is no class of remedies to which the system becomes so readily accustomed, and none in which such large doses can be tolerated, in especial diseases. Hence, when their use has to be continued, it is best to frequently substitute one for another, in order to prevent the formation of a dangerous habit. When once their use has become habitual, some degree of caution is requisite in abruptly withdrawing them, lest inordinate depression should follow.

They are used in medicine extensively for the relief of pain, which effect they accomplish by obtunding the sensibilities of the brain. Some are also employed for their stimulating effects; and many of them for an antispasmodic operation. They are, as a general rule, contraindicated in cases of plethora, fever of a high grade, and especially, cerebral congestion or inflammation.

They have received different names according to their different effects; *anodynes*, from their ability to relieve pain; *soporifics* or *hypnotics*, from their tendency to promote sleep, &c.

ALCOHOL, U. S.—The product of a peculiar change in grape sugar, known as the *vinous fermentation.* The conditions necessary for this change are a solution of sugar, the presence of some ferment, and a certain temperature. The chemical change which occurs is the conversion of sugar into alcohol and carbonic acid. The juices of various fruits contain all the elements for due fermentation. Thus the juice of the grape undergoes spontaneous fermentation, yielding *wine;* the juice of apples yields *cider;* the infusion of barley, *malt liquor*, &c. All such liquors—the result of fermentation—are named *fermented liquors*, and vary very much both as to flavour, and also as to the quantity of alcohol which they contain; thus the stronger wines contain about 20 per cent. of alcohol; the weaker wines about 10 or 12 per cent.; the malt liquors, as porter, ale, and beer, about 4 per cent. All the fermented liquors when submitted to distillation afford much stronger products, called *distilled liquors, ardent spirits*, or *spirituous liquors.* Brandy, gin, rum, &c., are examples. These contain about 50 per cent. of alcohol. When the quantity is exactly 50 per cent., or one half, the liquor is termed *proof-spirit.*

Any of the distilled liquors, when submitted to distillation, will yield the *Alcohol* of the Pharmacopœia, called also *rectified spirits of wine*,—having a sp. gr. of ·835. The alcohol thus procured contains as much as 15 per cent. of water, from which it cannot be entirely separated by any number of distillations. The *absolute alcohol* of chemists is never used in medicine.

The *Alcohol Dilutum* of the Pharmacopœias consists of equal measures of officinal alcohol and water: it is used in making certain tinctures; its strength is about that of the distilled liquors.

The various alcoholic liquors are used in medicine chiefly as stimulants in low states of the system. The *fermented* liquors, as wine, or the malt liquors, are usually preferred, unless a very decided stimulus is required, in which case *brandy* is employed.

Wine-whey is one of the best forms of administering wine; it is made by adding half a pint of wine (Madeira, Sherry, or Teneriffe) to a pint of boiling milk, separating the curd from the whey, and diluting the latter, if necessary, with rennet whey, and properly flavouring with sugar and spices.

The *malt liquors* may be employed as stimulants more freely than wine; they possess also tonic and nutritive properties: the best are porter and ale; beer is apt to prove acescent.

Alcohol is frequently employed externally, particularly in the form of ardent spirits, as a rubefacient: the effect is increased by mixing with red pepper. It will act as a local refrigerant if applied so as to be allowed to evaporate.

An evidence of the favourable influence of alcohol in disease, is when, under its use, the pulse becomes fuller, and at the same time slower; the skin moist, with an abatement of delirium.

Ether. (*Æther*, U. S.)—Chemically, the *oxide of ethyle.* Prepared by distilling together 2½℔s. alcohol and 1½℔s. sulphuric acid. The ether, as first procured, is contaminated with sulphurous acid, oil of wine, and some alcohol. It is purified from the acid by a redistillation with potassa; and from the alcohol by agitation with water. When thus purified it is named *rectified sulphuric ether.*

Prop.—A colourless limpid liquid, of a strong, agreeable, and peculiar odour; a hot, pungent taste; sp. gr. ·7, or a little less. Water takes up one part in ten; very soluble in alcohol; very volatile and inflammable.

Its effects on the system resemble those of alcohol, only more rapid and transient. It will affect the brain, producing intoxication; and, like alcohol, its effects are diminished by frequent repetition. Its impression is very speedily produced on the system by *inhalation;* by this means, a very powerful narcotic influence may be obtained. In this way it is much used as an anæsthetic agent.

As a medicine, ether is used chiefly as a powerful diffusive stimulant in cases of sudden and alarming prostration, as in metastatic gout, spasmodic asthma, angina pectoris, &c. It is best given in *emulsion,* made by rubbing it up with water by means of spermaceti. Externally applied it produces cold, if allowed to evaporate; or a rubefacient effect if confined to the skin.

Hoffman's Anodyne (*Spiritus ætheris compositus,* U. S.) is much employed. It contains oil of wine, ether, and alcohol, to the former of which it owes its peculiar fragrant odour, and which causes it to impart a milkiness to water; this is a test of its genuineness. It is much used to allay nervous irritations: it acts as an antispasmodic. Dose of ether, f℥ss to f℥j;—of Hoffman's Anodyne, about the same.

Chloroform. (*Chloroformum,* U. S.)—Prepared by distilling together alcohol, water, and chlorinated lime. It is the *terchloride of formyle* (C_2HCl_3). It is a very thin, colourless liquid, having a peculiar ethereal odour, and a hot, aromatic, saccharine taste, volatile, not inflammable, insoluble in water, soluble in alcohol and ether; sp. gr. 1·49; boiling point 142°; remarkable for the very small size of its drop, requiring from 250 to 300 to make one fluid drachm.

Its action is that of a *direct sedative;* used as an anodyne and calmative both generally and locally. Much employed by inhalation as an anæsthetic agent, but is not without danger; producing death apparently by suspending the heart's action. Dose internally, fʒi–ij. It has been found very useful in neuralgia.

Opium, U. S.—The concrete juice of the unripe capsules of *Papaver somniferum,* which is probably a native of Persia, but is now cultivated in various parts of the world. It is an annual plant, attaining

the height of 2 to 4 feet. The flower consists of four large petals, (Fig. 349). There are two varieties of the papaver somniferum, named the *white* and *black* poppy.

Fig. 349.

The *capsules* (poppy-heads)[1 2] are about one and a half to two inches in diameter, of a yellowish-brown colour, and filled with small seeds, which contain much fixed oil of a bland character, but no narcotic principle. The capsules themselves are slightly narcotic, and are sometimes employed in the form of decoction and syrup.

Opium is procured by making incisions in the half-ripe capsules, and collecting the juice which exudes, and properly drying it. It is obtained in large quantities in India, Persia, and Asia Minor; the chief supply of commerce being afforded from the latter country.

The different sorts of opium are the *India*, *Persia*, *Turkey*, and *Egyptian*.—The India variety is almost exclusively consumed in India and China; it consists of three varieties, *Malwa*, *Patna*, and *Benares* opium. The Persian very seldom comes to this country. There are two kinds of Turkey opium found in the markets,—the *Smyrna* and *Constantinople* opium.

Smyrna opium is the chief supply of the United States, and is the best variety; it comes in irregular rounded, or flattened cakes, covered with the capsules of some species of *rumex*, and enveloped in poppy leaves; has a reddish-brown colour; a softish consistence in the centre; becomes darker and harder on exposure; has a strong narcotic odour.

Constantinople opium is seldom seen in our markets;—occurs in irregular flattened cakes, presenting the remains of a poppy leaf on the exterior.

Egyptian opium occurs in flat cakes about three inches in diameter, free from capsules; of a darker colour, and more mucilaginous than the Smyrna variety. Little of it is now found in American commerce.

Marks of good opium are a strong narcotic odour, a bitter, acrid taste, when long chewed, exciting irritation of the fauces and mouth; a reddish-brown colour; when drawn across white paper should leave an interrupted stain.

Opium is inflammable; it imparts its virtues to water and alcohol.

Chemical composition very complex; the most important ingredient is *morphia*;—contains also *narcotina* and *codeia*, which are alkaline principles; and *narceine*, which is neutral; also, *meconin*, *meconic acid*, *thebaia*, or *paramorphia*, *gum*, *extractive*, and a volatile principle.

Tests.—*Morphia* is reddened by nitric acid, and made blue by sesquichloride of iron; iodic acid is converted into free iodine by morphia, and the iodine will afterwards strike a blue colour with starch. The most delicate test for *opium* in any form of solution is tincture of chloride of iron, which strikes a blood-red colour with the meconic acid of opium.

Physiological Effects.—Those of a stimulant narcotic; it excites the circulatory and nervous systems, and in full doses affects the brain.

Its first impression is to stimulate the heart and arteries, as evidenced by an increased frequency of the pulse, and greater heat of skin. This is soon followed by diminished sensibility, calmness, and sleep, with abatement of pain, and suspension of all the secretions, except that of the skin. This is succeeded by a degree of prostration, evidenced by a feeble pulse, cool, moist skin, languor, and depression. In large doses it is a narcotic poison, the symptoms being stertorous breathing, contracted pupils, a slow full pulse, great insensibility, and a livid countenance; followed by a feeble and threadlike pulse, relaxation of the muscles, and death. The *treatment* consists in an immediate evacuation of the stomach, either by the stomach-pump, or by a prompt emetic (sulphate of zinc or of copper), counteracting the tendency to sleep by external irritation; arousing the sensibility by dashing cold water upon the face and chest; and supporting the system, when it begins to sink, with diffusible stimulants. In cases of profound coma, electro-magnetism has been employed with success.

Therapeutical Applications.—Opium is employed in a great number of diseases; it is perhaps the very best *anodyne*, and is used for this purpose to relieve the pain of neuralgia, cancer, colic, &c. As a *hypnotic* or *soporific*, it is used in cases of morbid vigilance, except when dependent on inflammation of the brain. As a *stimulant* it is valuable in low forms of fever. As an *antispasmodic*, it controls spasm more effectually than most other remedies; in tetanus very large doses are required. As a *diaphoretic* it is useful in bowel affections, typhoid pneumonia, rheumatism, &c. It is also employed to arrest morbid discharges. On certain constitutions it produces peculiar effects, as obstinate wakefulness, nausea, delirium, and a tingling of the skin, attended with a miliary eruption.

The average dose of opium is one grain; but in mania-à-potu and tetanus, much larger doses are required. It may be applied *endermically* with advantage, in cases where the local effects are required; also by enema.

The following preparations are officinal in the United States Pharmacopœia:

Tinctura Opii (*Laudanum*—*Thebaic tincture*).—Prepared by

macerating opium, ℥ijss in diluted alcohol, Oij. It is a saturated tincture, and should always be of uniform strength. It contains about 37 grains to the fluid ounce. When long kept its strength is increased by the evaporation of the alcohol, in which case danger might result from administering it to infants. The dose equivalent to a grain of opium is ♏xiij, or 25 drops. Laudanum is frequently used as an external application.

Tinctura Opii Camphorata (*Paregoric Elixir*).—Prepared by the action of dilute alcohol on opium, benzoic acid, camphor, oil of anise, and honey. It contains two grains of opium in every fluid-ounce. It is much used in diarrhœa and coughs;—dose, about f℥ss; 18 drops equivalent to one of laudanum.

Tinctura Opii Acetata (*Acetated Tincture of Opium*).—Prepared by macerating opium in alcohol and vinegar combined;—dose, ♏x.

Acetum Opii (*Black Drop*).—Prepared by macerating opium, nutmeg, sugar, and saffron in dilute acetic acid. It is a strong preparation;—dose, 7 to 10 drops.

Vinum Opii (*Wine of Opium*).—Made by macerating opium and some of the aromatics in wine;—dose, ♏x.

Morphiæ Sulphas (*Sulphate of Morphia*).—Prepared by acting on a strong watery infusion of opium, with ammonia, which combines with the meconic acid, precipitating the morphia in a crystalline state; purified by boiling alcohol, and separated from the narcotina by means of ether. By these means the morphia is obtained in a crystalline state; it is next neutralized with sulphuric acid. It occurs in fine needle-shaped crystals, freely soluble in water;—dose, $\frac{1}{8}$–$\frac{1}{4}$ grain. The solution is officinal, (Liquor Morphiæ Sulphatis, U. S.). It contains one grain to f℥j of water;—dose, fʒj–ij.

The *hydrochlorate* and *acetate* of morphia are also used; their properties are similar to those of the sulphate.

The salts of morphia are much employed *endermically;* they possess all the valuable properties of opium.

Lactucarium, U. S.—The inspissated juice of the *Lactuca sativa,* or *garden lettuce,* which abounds in a milky juice, especially at the period of flowering. It is prepared by pressing out the juice with water, and evaporating to a proper consistence. It is of the consistence of a dry extract, of a brown colour, and strongly resembles opium in its effects, except that it does not produce constipation, nor diminish the secretions. Its dose is from five to ten grains.

Camphor. (*Camphora,* U. S.)—Product of the *Camphora officinarum,* or the *Laurus camphora* of Linnæus, an evergreen tree, of considerable height, growing in China and Japan. All parts of the tree abound in the odour and taste of camphor, but this is yielded in greatest abundance by the roots and young branches, when they are cut up, boiled in water, and sublimed into inverted straw cones. Thus obtained, it constitutes the *crude camphor* of commerce. It is puri-

Fig. 350.

fied by resublimation, along with quicklime, when it becomes *refined camphor.*

It is solid, colourless, and translucent, with a crystalline texture, tough and difficult to pulverize; has a strong penetrating odour, with a bitter pungent taste, followed by a sense of coolness; rather lighter than water; very volatile and inflammable; but slightly soluble in water; very soluble in alcohol, ether, the fixed and volatile oils.

Borneo or *Sumatra* camphor is in white crystalline fragments; it occurs in solid masses in the cavity of the wood of the *Dryobalanops camphora.* It is not found in our markets.

Effects on System.—In moderate doses, it usually produces a gentle excitement, heat of skin, and fulness of pulse, with a tendency to diaphoresis; its stimulant effect is, however, sometimes preceded by a sedative action. It is applicable in typhoid cases, accompanied with nervous derangement. It is sometimes usefully combined with opium, in rheumatism, &c.

Dose, in substance, from 5 to 10 grains. The *emulsion* is made by rubbing up the camphor with gum, sugar, myrrh, and water.

Aqua Camphoræ, U. S. (*Camphor Water*)—is made by adding a few drops of alcohol to camphor, and then rubbing up with carbonate of magnesia and water; it contains 3 grains to every fluidounce.

Tinctura Camphoræ, U. S., often called *Spirits of Camphor,* contains two ounces of camphor to the pint of alcohol;—chiefly employed as an embrocation to sprains and bruises; used internally in colic and cholera;—dose, 5 drops to f ʒj.

Linimentum Camphoræ, U. S. (*Camphor Liniment*)—consists of camphor dissolved in olive oil; used as a mild embrocation.

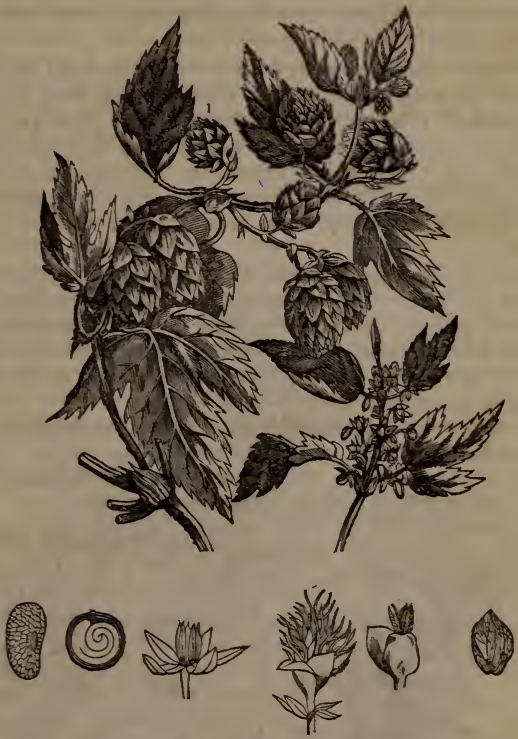
Tinctura Saponis Camphorata, U. S., improperly called *Soap Liniment,*—made by mixing together camphor, Castile soap, oil of rosemary, and alcohol. It is a yellowish oleaginous liquid, much used as a stimulant anodyne lotion in sprains, rheumatism, &c.

Linimentum Saponis Camphoratum, U. S., commonly known as *Opodeldoc,*—made like the last-mentioned preparation, except that an animal soap is used instead of a vegetable one, in consequence of which it coagulates on cooling, and yields a soft solid, which liquefies at the temperature of the body;—*uses,* the same as the others.

Hops. (*Humulus,* U. S.)—The *Humulus lupulus* (Fig. 351), is a native of Europe and North America. It has a perennial root, which sends up annually several rough, flexible, twining stems. The male

and female flowers grow on different plants. The part used is the fruit, or rather strobiles,[1] which are collected when ripe, dried, and

Fig. 351.



packed in bales. They have a greenish-yellow colour; a bitter, astringent, and somewhat aromatic taste; impart their virtues to water and alcohol. A reddish powder is found at the base of the scales, termed *lupulin*, which contains all the virtues of the hops. These virtues depend upon a peculiar principle called *lupulina*, which resides both in the hops and in the powder.

Effects on System. — Stomachic, tonic, and slightly narcotic. The odorous emanations from hops are hypnotic; for this purpose the *hop-pillow* is employed, made by previously moistening the hops with spirits, to increase the effect, as well as to prevent a rustling noise. Hops are extensively employed in making malt liquors. They are best given in the form of infusion (*hop tea*), made in the proportion of ℥ss to Oj water. The decoction and extract are objectionable.

Lupulin may be given in the dose, 6 to 12 grains, made into a pill. The tincture of lupulin (*Tinc. Lupulinæ*) is officinal, as well as the tincture of hops (*Tinc. Humuli*). They are excellent remedies in the dyspepsia of drunkards, and in mild mania-à-potu;—dose, f ʒss to f ʒj. Hops are sometimes applied externally, in the form of poultice; it has an anodyne effect.

Bittersweet. (*Dulcamara*, U. S.)—It is doubtful whether this medicine should have a place among the narcotics, since its influence over the cerebral functions is very feeble. The plant yielding it is the *Solanum dulcamara*, or *woody nightshade;* the parts employed are the stem and twigs, which should be collected in the autumn. They are about the thickness of a common quill, of a light brownish-gray colour, without odour, and have a bitter taste followed by sweetness.

Uses.—Their chief employment is an alterative in chronic skin diseases, given in the form of decoction (*Decoctum Dulcamaræ*, U. S.), made by boiling ℥j in Ojss of water down to Oj. It may also be used in the same cases advantageously as a wash. Its virtues depend on an alkaline principle named *solania*, which is also found in the *Solanum tuberosum*, or common potato.

Dulcamara has been supposed by some to be antaphrodisiac, and for this purpose has been employed in the cases of the insane.

Extractum Dulcamaræ, U. S.—Dose, gr. v–x.

Fig. 352.

Henbane Leaves and Seeds. (*Hyoscyami Folia et Semen*, U. S.)—Leaves and seeds of the *Hyoscyamus niger*, a biennial plant (Fig. 352), native of England, growing from one to three feet high; thickly furnished with sessile leaves, of a pale-green colour. All parts abound in narcotic properties, but the leaves and seeds alone are officinal. The leaves of the second year, and of plants grown in sunny situations, are said to be the strongest. They ought to have a mucilaginous, slightly bitter taste, and should retain some of the narcotic odour of the plant. They depend for their virtues upon a peculiar crystalline, alkaloid principle, named *hyoscyamia;* this is yielded to water and alcohol.

Effects.—Very slightly, if at all,

excitant; narcotic, anodyne, and soporofic; resembles opium in moderate doses, except that it does not constipate. Large doses occasion dizziness, dilatation of the pupil, and slight delirium. It may be used in cases requiring the exhibition of a gentle anodyne and calming remedy. It is given in *powder*,—dose, 5 to 10 grains; in *extract* (inspissater juice), (*Extractum Hyoscyami*, U. S.)—dose, ½ gr. to 3 grains; in *alcoholic extract*—prepared by percolation with alcohol on the *dried* leaves, and evaporating to a proper consistence,—dose, gr. ij; in *tincture*,—dose, f ʒss–j. The preparations of hyoscyamus, as found in the shops, are very variable.

THORNAPPLE LEAVES AND ROOT. (*Stramonii Folia et Radix*, U. S.)—The *Datura stramonium* (Fig. 353), is an annual, very com-

Fig. 353.

mon in different parts of the world, growing from 3 to 6 feet high All parts are acrid and narcotic, but the leaves and seeds only are used in medicine. These owe their efficacy to a very poisonous peculiar principle, called *daturia*.

Effects.—A strong acrid narcotic; diminishes sensibility, causes cerebral disturbance, as manifested by giddiness, headache, dilatation of the pupil, and obscurity of vision; also, calmative and antispasmodic, occasionally will produce diaphoresis and diuresis.

Used,—in neuralgia, rheumatism, epilepsy, and mania; also in spasmodic asthma, where it is employed by smoking the dried leaves or root in a common pipe; caution is required in the case of the aged or plethoric. Given in *powder*—dose, 2 or 3 grains; in *seed*—dose, one grain twice a day; *extract of the leaves* (*Extractum Stramonii Folio-*

rum, U. S.),—dose, one grain twice a day; *extract of the seeds* (*Extr. Stram. Seminis*, U. S.),—an alcoholic extract—dose ¼ to ½ a grain.

The extract is sometimes used by American oculists to dilate the pupil of the eye previous to the operation for the cataract.

The ointment (*Unguentum Stramonii*, U. S.) is best made by boiling the fresh leaves in lard: it has a light-green colour, and may be employed in the same cases as the belladonna ointment.

Deadly Nightshade. (*Belladonna*, U. S.)—The *Atropa belladonna* (Fig. 354.) is an herbaceous perennial plant, a native of Europe. It has a thick fleshy root, several downy, erect stems; ovate, entire leaves, and pendent, bell-shaped, purplish flowers. All parts are possessed of narcotic properties, though only the leaves are officinal. The dried leaves have a dull-greenish colour, a slight narcotic odour, and a bitter nauseous taste. Active principle, *atropia*, a violent poison.

Fig. 354.

Effects, &c.—Anodyne, antispasmodic, and rather sedative; one of its earliest impressions is a dryness and stricture of the fauces; it usually causes dilatation of the pupil, giddiness, and dimness of vision; in large doses, great thirst, dysphagia, violent delirium, blindness, and occasionally convulsions, coma, and death. Its fatal effects are usually accompanied with marks of gastro-intestinal inflammation.

Uses.—As an anodyne to relieve the pain of neuralgia; as a resolvent or discutient in chronic indurations; as an antispasmodic in the latter stages of hooping-cough; by some supposed to be a prophylactic in scarlatina. Externally applied, it produces a local anodyne

impression; and if applied to the eyes, it causes dilatation of the pupil, for which purpose it is frequently used by the oculist. It is employed in substance, infusion, and extract. Dose of *powder*, one grain twice a day; of the *extract*—an insipissated juice—¼ of a grain to one grain. —*Extract. Belladon. Alcoholicum*, U. S., dose the same. The dose in each case is to be increased until dryness of the throat is produced.

Emplastrum Belladonnæ, U. S.,—made by mixing the extract with lead plaster—is used to relieve neuralgic pains; also in dysmenorrhœa.

Unguentum Belladonnæ, U. S.,—made by rubbing up ʒi of the extract with ℥i of lard. Used to painful or sprained joints, and sometimes applied to the rigid os uteri in cases of protracted labour; used also for dilating the pupil for the operation of cataract.

The three last-mentioned narcotics, from their tendency to produce delirium, have been sometimes named *Delirifacients*.

Extract of Hemp. (*Extractum Cannabis*, U. S.)—The plant which yields this medicine is the common hemp (*Cannabis sativa*, var. *Indica*), a native of Persia, but cultivated throughout the world. It secretes a peculiar resinous matter, which is much more abundant in the plants grown in India than in those of Europe or America. This resin is sold by the natives under the name of *churrus*. In the East, the dried flowering tops, from which the resinous matter has not been removed, is also employed under the name of *gunjah*.

The active principle is a resinous matter, called *cannabin*, soluble in alcohol and ether; also a volatile oil.

Effects on the System.—It exhilarates the spirits, increases the appetite, alleviates pain, relaxes spasm, produces sleep, and is stated to act as an aphrodisiac. In large doses it occasions delirium of a peculiar character, attended with a cataleptic condition. Dr. Pereira says, that, in his hands, its effects very much resembled those of opium.

Uses.—In India it has been employed with great benefit in tetanus, hydrophobia, rheumatism, and cholera; its operation being chiefly directed to the relaxation of spasm. It has been in use only for a few years in America.

The *extract* is made by boiling the dried flowering tops (gunjah) in alcohol until the resin is dissolved out, and then distil off the spirit; *dose*, gr. j–v. The *tincture* (made by dissolving three grains of the extract in a fluid drachm of diluted alcohol), is sometimes employed.

CLASS VI.

EXCITO-MOTOR STIMULANTS.

This class of stimulants produce their effects through *reflex action*,—that is, by so impressing the spinal cord as to excite the anterior or motor centres into action, and consequently to produce muscular movements. These may frequently be of a spasmodic character, and even amount to general convulsions.

As remedial agents, they are employed where it becomes necessary to arouse the muscular structure into action, though usually in cases of local or temporary torpor, as in partial paralysis, or in inertia. Some of them possess decided narcotic properties.

Nux Vomica, U. S.—Seeds of the *Strychnos nux vomica*, a middling-sized tree, growing in the East Indies. The fruit is the size of an orange, containing many seeds imbedded in a juicy pulp. These are rather less than an inch in diameter, circular and flattened, slightly concavo-convex. Externally they are covered with a whitish silky down. The interior is hard, of a horny consistence; difficult to powder. They have no odour, but an intensely bitter taste; they yield their active principle to dilute alcohol more readily than to water.

Nux vomica owes its virtues to two alkaline principles which it contains, called *strychnia* and *brucia*, which exist in combination with *igasuric acid*.

Strychnia may be procured either from nux vomica, or from *St. Ignatius' bean*, which contains it in large quantities. As found in the shops it is usually granular, but it may be made to crystallize. Colour, white; no odour; taste intensely bitter; almost insoluble in water; soluble in alcohol; slightly so in ether; unites with acids to form salts. *Brucia* is reddened by nitric acid; its properties are similar to those of strychnia, though feebler.

Effects on System.—Given in very small doses it acts as a tonic to the digestive organs; in rather larger quantities, its influence seems to be directed chiefly to the muscular system, through the medium, however, of the spinal marrow. There is, at the same time, an increased sensibility to external impressions, trembling of the limbs, and slight convulsive motions, which subsequently extend to the involuntary muscles, producing, in poisonous doses, the most violent tetanic spasms; the individual perishes apparently from asphyxia, brought on by the spasm of the respiratory muscles. There is no narcotism, nor is the pulse much affected.

There is strong reason for believing that the peculiar impression of the medicine is exerted entirely through the medium of the spinal marrow, and not through the medium of the brain.

Uses.—The cases which would seem most obviously to be met by nux vomica, or strychnia, are those attended with deficient nervous energy, as indicated by a torpid or paralytic condition of the muscles. The cases of paralysis to which it is applicable are such as are not attended with organic lesion of the brain. It is said to be more advantageous in paraplegia than in hemiplegia; also in local palsies, and in incontinence of urine, depending on a loss of power of the muscles of the bladder. The first obvious sign of its influence on the the system, in cases of paralysis, is a tingling sensation experienced in the part affected.

Dose of the *powder*, 3 to 5 grs. three or four times a day, gradually increased until a sensible effect is produced. A better form is the *alcoholic extract* (*Extrac. Nucis Vomicæ*, U. S.), the dose of which is from half a grain to two grains. The *tincture* (*Tinc. Nucis Vomicæ*, U. S.) is made in the proportion of ʒiv to the pint; dose, gtt. x–xx.

Dose of strychnia, $\frac{1}{16}$th to $\frac{1}{12}$th of a grain, three times a day.

Strychnia may be applied *endermically* in cases of amaurosis, when not of an organic character,—half a grain being sprinkled upon a blistered surface on the temple.

Ergot. (*Ergota*, U. S.—*Spurred Rye.*)—A diseased product of the *Secale cereale*, or common rye, caused by a fungous parasite,—in the form of numerous sporidia, visible by the microscope. This fungus, when lodged upon any of the *grasses*, will produce the diseased condition of the seed called *ergot* or *spur*. Rye grown upon poor and wet soils is most subject to it. Occurs in spurred grains from half an inch to an inch in length, cylindrical, tapering, and curved like a cock's spur; colour, externally purplish-brown; internally, dull white; odour, in mass, resembling that of putrid fish; taste, acrid and unpleasant; —virtues to boiling water and alcohol. It contains an oil and *Ergotine.*

Effects.—In the ordinary dose it occasions no perceptible effects on the male system; but on the female it produces decided uterine contractions, particularly in the impregnated condition; and these contractions are of a *tonic* nature. It also sometimes produces nausea, giddiness, and stupor, indicating a narcotic influence.

Ergotized grain, used for a length of time, has been known to produce fatal effects — such as dry gangrene, typhus fever, and convulsions.

Uses.—Chiefly to facilitate labour; but *only* when the delay arises simply from a want of contractile power of the uterus; if given when the diameters of the pelvis are too small for the passage of the fœtal head, it will probably produce rupture of the uterus—also to aid in the expulsion of the placenta, and of clots, hydatids, and polypi; also in uterine hemorrhage.

Dose of powder, ℈j,—to be repeated if necessary. *Infusion*, made with ʒj of ergot to f℥iv boiling water; dose, one-third. Dose of the *Oil*, 20 drops. *Vinum Ergotæ*, U. S.,—dose, fʒj to f℥iij. Ergot should not be kept in the powdered state.

CLASS VII.

ARTERIAL SEDATIVES.

MEDICINES which tend directly to depress the action of the circulation; producing a slower and weaker pulse, and diminishing the frequency of the respirations, without any special tendency to the nervous system.

They have also been named *refrigerants*, from the cooling effect generally produced upon the surface of the body by their use, owing to a diminished capillary circulation.

They are indicated in cases of high vascular action, as the different phlegmasiæ, and fevers unaccompanied with typhoid symptoms. Although *sedative* in their general impression upon the system, some of them, as antimony, produce a local stimulant effect upon some of the organs.

They cannot be employed as substitutes for bloodletting, since the latter actually takes away materials from the circulating fluid; but they are valuable adjuvants to this treatment, and are much employed with this view.

ANTIMONY. (*Antimonium*, U. S.)—The antimonials are the most sedative of all the refrigerants, and are used very extensively with this indication. Given in quantities too small to produce any obvious effect in the healthy system, they nevertheless prove *alterative* in disease. In rather larger doses, though still too small to occasion nausea, they produce a decided sedative action; upon the blood they act as antiplastics. In still larger doses, they cause nausea, thereby directly increasing their power as sedatives or refrigerants. In yet larger quantities they vomit. Although sedative to the system at large, the antimonials act as stimulants to the lungs, skin, and kidneys, and sometimes the liver and salivary glands. They act by being taken up by the circulation. Their effects continue for some time after the suspension of their use, and by cautiously increasing the dose, great *tolerance* of the medicine may be induced.

The preparations of antimony most used are the following:—

1. *Tartar Emetic.* (*Antimonii et Potassæ Tartras*, U. S.)—Prepared by saturating the excess of acid in the bitartrate of potassa (cream of tartar), with the sesquioxide of antimony, by boiling them

together. It should always be crystallized, to free it from impurities.

Prop. — A white, crystalline salt, without odour, of a nauseous, metallic state, efflorescent, very soluble in water, insoluble in pure alcohol; decomposed by the pure alkalies, alkaline carbonates, and the vegetable astringents.

Effects and Uses. — The best of the antimonials; used as an alterative in chronic cutaneous diseases, and in scrofulous affections; but requires to be persevered in for some time. Dose as an alterative, $\frac{1}{32}$ to $\frac{1}{16}$ gr. In rather larger quantities, as from $\frac{1}{12}$ to $\frac{1}{6}$ gr., it acts as a refrigerant, and may be given whenever the action is above the normal standard, as in fevers, inflammations—especially of the lungs, —when it acts also by increasing the secretion. It has been given in very large doses in acute pneumonia and other pectoral diseases, on the *contra-stimulant* plan of Rasori, as a substitute for the lancet, the patient taking from one to two grains, and upwards, every two hours. There is considerable risk, however, in this method, arising from the excessive depression which is sometimes produced, and also from the effect on the stomach and bowels. Six or eight grains may be given daily with safety for three or four days, in pneumonia.

The *poisonous* effects are an austere, metallic taste, excessive nausea and vomiting, burning pain in the stomach, colic, extreme depression of the circulation, spasms, watery evacuations from the bowels, and great prostration; resembling very much a violent case of cholera. The remedies are demulcent drinks, astringent infusions, and stimulants, both internal and external.

Antimonial Wine. (*Vinum Antimonii*, U. S.) — A solution of tartar emetic in wine, in the proportion of gr. ij to f℥j. The best wine must be used — as the Teneriffe, Sherry, or Madeira, or else the solution will not be perfect. This preparation is employed for its diaphoretic and expectorant effects; also as an emetic for children. Dose 20 drops to f℥j.

Tartar Emetic Ointment. (*Unguentum Antimonii*, U. S.) — Made by rubbing up ʒij of powdered tartar emetic with ℥j of lard. Used to the skin as a counter-irritant by its pustulation, in chronic internal disorders of the chest or abdomen.

2. *Precipitated Sulphuret of Antimony.* (*Antimonii Sulphuretum Præcipitatum*, U. S.) — Prepared by boiling together the ter-sulphuret of antimony and a solution of potassa; strain, and add sulphuric acid while yet hot; then wash away the sulphuret of potassium, and dry the precipitated sulphuret. It is an orange-red, insoluble powder, composed, chemically, of the mixture of the oxide and sulphuret of antimony.

Kermes Mineral is a similar compound, made like the preceding, with the exception that no acid is added, but the precipitate falls spontaneously.

Golden Sulphur of Antimony is formed by adding an acid to the

liquid, after the precipitation of the Kermes mineral: it contains some uncombined sulphur.

None of these preparations are much used at present. They are occasionally given as alteratives, combined with guaiac and calomel, in the form of *Plummer's Pill*, in chronic skin diseases. Dose, 1 to 2 grs.

3. *Antimonial Powder* (*Pulvis Antimonialis*), made in imitation of *James's Powder.*—Prepared by burning the sulphuret of antimony with hartshorn shavings, in a wide-mouthed vessel. It consists of phosphate of lime and oxide of antimony; colour, white; no taste or smell; insoluble in water; uncertain in its operation. Used in fevers and cutaneous diseases. Dose, 3 to 8 grs.

VEGETABLE ACIDS.

Nearly all of them are refrigerant, and are well adapted, when properly diluted, to inflammatory and febrile complaints. Too long used, they enfeeble digestion, and produce symptoms of marasmus. Those most employed in medicine are the Acetic, Citric, and Tartaric.

Acetic acid—(*Acidum Aceticum*, U. S.)—in the form of vinegar, diluted with water, is a refreshing drink in febrile cases. It is also useful as a cooling application to the surface. The strong acetic acid is an irritant poison. Dilute acetic acid and distilled vinegar are of about equal strength.

Citric acid—(*Acidum Citricum*, U. S.)—exists in the lemon, lime, sour orange, tamarind, and many other fruits. It is used either in the form of lemon-juice, or the solid crystalline state. The decomposition of lemon-juice may be partially prevented by exposing it to a freezing temperature, whereby all the watery parts are separated, and the juice much concentrated; or by making it into a syrup with sugar.

The crystalline acid is prepared by saturating lemon-juice with chalk, and then decomposing the citrate of lime by sulphuric acid, and evaporating. The crystals are large, white, transparent rhombs, of a very sour taste, soluble in water; apt to be adulterated, if in powder, with tartaric acid; fraud detected by carbonate of potassa, which causes no precipitate with citric acid. A solution in the proportion of ʒixss citric acid to Oj water, is about the strength of lemon-juice; ℈j of acid to Oj water is the proportion for lemonade. It is a valuable *antiscorbutic;* and has been used in large doses in *acute rheumatism.*

Tartaric acid—(*Acidum Tartaricum*, U. S.)—is found in the juice of the grape, tamarind, &c. It is much employed as a cheap substitute for citric acid. Used in *soda* and *seidlitz powders*.

SALINE SUBSTANCES.

Most of the neutral salts produce a refrigerant effect upon the

system, both as a direct result, and indirectly, in consequence of the purgative power which many of them possess. Most of them are described under the head of *Cathartics.* The one most especially refrigerant, is

Nitrate of Potassa (*Potassæ Nitras,* U. S.), commonly called *Saltpetre,* or *Nitre.* It is procured from the banks of the Ganges, as a natural exudation from the soil; also from artificial nitre-beds in Europe. When purified, the crystals are large, six-sided prisms, with numerous transverse striæ; no odour; taste, saline and cooling; soluble in water, not in pure alcohol; fuses by heat, when it may be run into moulds; a high heat decomposes it. *Effects.*—In moderate doses, it reduces the circulation, and diminishes the temperature of the body, not, however, as was supposed, by its solution in the stomach. It exerts also an antiplastic influence on the blood, rendering it less inflammatory. At the same time, it is diuretic, or diaphoretic, according as the patient is kept cool or warm. Large quantities are apt to produce nausea and vomiting, and even poisonous effects; though very considerable doses may be taken with impunity, provided they be given largely diluted in some mucilaginous fluid.

Used in fevers of a high grade, as an adjuvant to the lancet; also very useful in hemorrhages, in acute rheumatism, and in all inflammations, except those of the stomach and bowels. Often combined with tartar emetic, and sometimes with calomel. Dose, 5 to 10 grs. every hour or two. The *Nitrous Powders* consist of a combination of nitre, tartar emetic, and calomel,—much employed in febrile complaints of a bilious character.

CLASS VIII.

NERVOUS SEDATIVES.

These are medicines which occasion great depression of the system, attended often with nausea, sometimes with vomiting and purging, weakness and irregularity of pulse, syncope, giddiness, confused vision, and occasionally convulsions, delirium, and stupor. They are named by some writers *sedative narcotics,* from their effects on the brain. The most important of this group are Foxglove and Tobacco.

Foxglove. (*Digitalis,* U. S.)—The *Digitalis purpurea* is a biennial plant with long radical leaves, from the midst of which an erect stem arises the second year, terminated by a raceme of beautiful purple flowers. The parts used in medicine are the *leaves,* which require to be selected and dried with great care, and preserved so as to exclude the light. When dried they should have a fine green

colour, a slight odour, with the strong bitterness of the recent plant. They contain a peculiar principle termed *digitalin*, on which their activity depends.

Effects on System.—Those of a sedative narcotic; causes tightness and dull pain in the forehead, vertigo, dimness of vision, confusion of intellect, great reduction of the heart's action—in some cases as much as 30 pulsations a minute. It is also powerfully diuretic. Poisonous doses produce nausea and vomiting, great prostration, cold sweats, hiccough, convulsions, and death. It is cumulative in its action, and therefore its effects require to be carefully watched.

Digitalis is chiefly used to diminish the action of the heart in hypertrophy and dilatation of that organ, also in certain forms of nervous palpitations; in aneurism of the aorta; in inflammation, as an adjuvant to the lancet; in scarlatina, pertussis, epilepsy, mania, and some forms of hemorrhage; also as a diuretic. Dose in substance, gr. j, two or three times a day; of the *infusion* (*Infusum Digitalis*, U. S.), made by adding ℥ij to Oj of water, f℥ss; of the *tincture* (*Tinc. Digitalis*, U. S.), ♏x to ♏xxx.

Tobacco. (*Tabacum*, U. S.)—Leaves of the *Nicotiana tabacum*, an annual plant, native of tropical America. It has an erect, hairy stem, long sessile leaves, viscid and hairy. As found in the shops it is of a yellowish-brown colour; strong, narcotic, penetrating odour; bitter, acrid, and nauseous taste. Alcohol and water extract its virtues. Its active principle, named *nicotina*, is a volatile, alkaline, oily liquid, without colour, with a very acrid taste, and an odour resembling that of tobacco; it is extremely poisonous. Tobacco contains another principle named *nicotianin*, a fatty substance, seeming to owe its properties to containing a little nicotina. An *empyreumatic oil* is yielded by the destructive distillation of tobacco; it gives the peculiar odour to old tobacco-pipes; it is very poisonous. This is the *oleum tabaci* of the Pharmacopœia.

Effects on System.—In very small quantities, it is a sedative to the system at large; in larger doses, acts on the brain, producing vertigo and stupor, together with nausea and vomiting, extreme depression, coldness of the skin, syncope, and sometimes convulsions. Small doses repeated are more dangerous than a large one, in consequence of the latter being rejected from the stomach. In its effects, it resembles digitalis, surpassing it, however, in its depressing influence over the muscular system, but being inferior to it in its influence over the circulation.

Uses.—Chiefly to relax the muscular system, as in strangulated hernia, obstinate constipation from spasm of the bowels, or retention of urine from spasm of urethra. Not much given by the stomach on account of the excessive nausea it produces; chiefly by *enema* (infusion, made in proportion of ℥j tobacco to Oj of water,—one-third to

be used at once). Dangerous and even fatal symptoms have resulted from the tobacco injection. It may also be used in the form of cataplasm, in cases of spasmodic croup, lead colic, tetanus, and rheumatic affections.

Wine (*Vinum Tabaci*, U. S.)—Used as a nauseant and diuretic.

Tobacco ointment (*Unguentum Tabaci*, U. S.), is made by boiling fresh tobacco in lard; it is used in cutaneous diseases, especially *tinea capitis*. The ointment is sometimes made from the oil.

INDIAN TOBACCO. (*Lobelia*, U. S.)—The *Lobelia inflata* is a native of America, where it was employed as a medicine by the aborigines. It is an annual plant, growing a foot or more in height, with an erect stem; the fruit is an inflated capsule. The whole shrub is used in medicine. It contains a volatile, acrid, peculiar principle, named *lobelina*, analogous to *nicotina*.

Effects.—Narcotic, acrid, emetic, and antispasmodic, strongly resembling those of tobacco. It is chiefly used as an antispasmodic in asthma, either by giving it in full doses so as to excite vomiting, or in small quantities frequently repeated till nausea comes on. Its infusion may be used in the form of enema in strangulated hernia. Used internally chiefly in the form of *tincture* (*Tinc. Lobeliæ*, U. S.),—dose, f℥j. Fatal effects have followed the empirical administration of lobelia.

ACONITE. (*Aconitum*, U. S.)—Leaves and root of the *Aconitum napellus*, or monkshood, a perennial herbaceous plant, growing in the mountainous parts of Europe. The root is tapering; leaves deeply divided; flowers of a dark-blue colour. All parts are possessed of acrid properties, and when fresh, emit a faint narcotic odour. *Taste* of the leaves and root, at first bitterish and acrid, and followed by a a peculiar tingling sensation, often amounting to numbness, which extends to the soft palate.

Effects.—Those of a sedative narcotic, or rather of a *benumber*, since it diminishes sensation, causes a feeling of numbness and tingling along the extremities, muscular debility, contraction of the pupil, but no delirium or stupor. Poisonous doses cause excessive burning and numbness of the mouth, throat and stomach, with violent vomiting, prostration, great loss of sensibility, but neither coma nor convulsion. It differs from tobacco and digitalis in not producing stupor or giddiness, as a general rule. It yields its virtues to alcohol. Its peculiar properties depend upon an alkaline principle termed *aconitia* or *aconitina*; there is also a volatile acrid principle, besides some extractive, &c.

Aconitia is a white solid substance, existing in combination with an acid. It possesses all the powerful properties of the plant in a highly concentrated degree. In fact, when pure, it is as subtle a poison as prussic acid; though much of the alkaloid sold in the shops is worthless. Its very high price forms an objection to its use. The *alco-*

holic extract of aconite (*Extr. Aconiti Alcoholicum*, U. S.), when well prepared, forms an excellent substitute for the aconitia. The common extract of the Pharmacopœia (*Extractum Aconiti*, U. S.)—an inspissated juice—is not so good.

Uses.—Internally in chronic rheumatism, gout, cancer, &c.; but it is more valuable as an external application, particularly in neuralgia, when applied in the form of tincture.

Dose, of the *purest aconitia*, $\frac{1}{50}$th of a grain (Pereira); but is very seldom used; of the *tincture of the root* (*Tinct. Aconiti Radicis*, U. S.)—a saturated tincture—5 drops three times a day; of the *tincture of the leaves* (*Tinct. Aconiti Foliorum*, U. S.), gtt. xx–xxx; of the *alcoholic extract*, $\frac{1}{8}$th of a grain. The ointment is made by adding the aconitia to fresh lard; it is used in neuralgia.

HEMLOCK. (*Conium*, U. S.)—Leaves and seeds of the *Conium maculatum*, a biennial umbelliferous plant, a native of Europe, but naturalized in the U. S. It has a spindle-shaped root, and a smooth branching stem marked with purple-coloured spots. The leaves are compound, tripinnate and bipinnate. Believed to be the same plant as the κωνειον of the Greeks, and the *cicuta* of the Romans.

Fig. 355.

The leaves should be collected from plants growing in sunny situations, and preserved in close vessels. When well preserved they retain their green colour and narcotic odour. *Taste* bitter and nauseous. Imparts its virtues to alcohol and ether. The *seeds* are small, and have a slight odour and taste, but retain all the active properties of the plant. The active principle is an alkali named *conia*, of a highly acrid nature, sparingly soluble in water, forming salts with the acids.

Effects on System.—Said by Christison, who has experimented upon it, to act as a direct sedative to the cerebro-spinal system, occasioning

paralysis of the voluntary muscles, and subsequently of the muscles of respiration, together with vertigo and general debility. Its influence appears to be exerted more over the nerves of motion than over those of sensibility, producing a paralyzing effect upon the muscles supplied by the former.

Uses.—Employed by the ancients as a discutient or resolvent, in enlargements and indurations of the glands and viscera; also in scrofula, bronchocele, leprosy, syphilis, and ulcers of a cancerous character. Its chief reputation has been in cancer, for which it was introduced into practice by Störk of Vienna; but it is highly probable that its alleged virtues in this disease are chiefly due to its narcotic powers.

Hemlock is used in *powder*—dose, 3 or 4 grains two or three times a day; *tincture*—dose, fʒss to fʒj; *extract*—an inspissated juice of the leaves,—3 grs. two or three times a day.

Hydrocyanic Acid. (*Acidum Hydrocyanicum*, U. S.)—This acid is a compound of hydrogen and cyanogen, and is of vegetable origin, being developed in the bitter almond, cherry laurel, and in most of the species of the *prunus* and *amygdaleæ.* Usually obtained, however, by decomposing the bicyanide of mercury, by hydrochloric, or hydrosulphuric acid. The concentrated, or purest acid, is a limpid fluid of a sp. gr. of 0·697; having a strong peculiar odour, which, however, differs from that of the oil of bitter almonds; extremely volatile; boils at 79°; has a great tendency to undergo decomposition, and is extremely poisonous. It is never employed in the undiluted form.

The *medicinal* or *dilute* hydrocyanic acid is procured by the reaction of dilute sulphuric acid on ferrocyanide of potassium, or by that of hydrochloric acid on cyanide of silver in water. Its properties are similar to those of the concentrated acid, only in a less degree; it contains 2 parts of real acid in 100 of water. It is very liable to decomposition, especially when exposed to the light; hence it should be kept in a dark place.

Effects on System.—In very small doses, repeated, it causes a bitterish taste, nausea, vertigo, faintness, but no very certain alteration of the circulation. The more violent effects are great and sudden prostration, giddiness, and faintness, tetanic convulsions, and insensibility, difficult and spasmodic respiration, and death. The peculiar odour of the acid is usually very distinct. The post mortem appearances are not very definite. The best *antidotes* are chlorine, ammonia, the cold affusion, and artificial respiration; a mixture of a proto and per-salt of iron with carbonate of potash is also recommended, converting the acid into *Prussian blue.*

Uses.—Internally, as a remedy in certain nervous affections, particularly *gastrodynia;* also in hooping-cough, asthma, epilepsy, hypertrophy and palpitation of the heart, and in the cough of phthisis. Externally, it is employed as a wash in certain forms of skin disease,—the proportions being ʒij of the dilute acid to Oss distilled water. Dose

of the officinal acid, 1 to 3 drops, repeated till some obvious effect is produced.

As a substitute for hydrocyanic acid, the *cyanide of potassium* may be used, since it is not, like the former, apt to undergo decomposition when kept. It may be given in the dose of ¼ gr., gradually increased. When swallowed it becomes converted into hydrocyanic acid, by the acid of the stomach. Another good substitute is the *oil of bitter almonds*—in the dose of ¼ of a drop, to be repeated.

CLASS IX.

ALTERATIVES.

ALTERATIVES are medicines which, by slowly and gradually modifying the nutrition of an organ or tissue, subvert diseased action, and bring about a healthy condition.

No especial evidence of their action upon the system is afforded, except the gradual disappearance of disease, and the restoration to health.

It is highly probable that most, if not all the true alteratives act by entering into combination with the nitrogenous principles, either of the blood, or of the tissues, forming compounds incompatible with the continuance of the morbid nutrition of the part. Now, by continuing their use for some time, the nutrition becomes completely modified; and, on discontinuing them, the tissue gradually returns to a healthy nutrition; the compounds, which had in the mean time been formed, being removed by absorption.

It can easily be understood, then, how such remedies, if pushed too far, will prove injurious by breaking down the crasis of the blood, and inducing a cachectic condition.

Some of them appear to possess the power of especially attacking morbid deposits of a proteine nature, as indurations, or thickenings, from a deposit of coagulable lymph, &c.; such an action is sometimes called *liquefacient*.

MERCURY. (*Hydrargyrum*, U. S.)—In the *metallic state* it is not believed to act upon the system; but, when swallowed in that state, it very soon is oxidized, and then becomes efficient. The *vapour* from metallic mercury is known to be active, as is seen from its effects on artisans who work in that metal. The effects of mercury on the system may conveniently be considered under the two heads of its *alterative* and its *salivant* operation. When given in very minute doses, and continued for a length of time, it augments all the secretions,

causing increased action of the mucous membranes generally; at the same time, the absorbents are stimulated to greater activity, so that under its operation, effused fluids are seen to diminish or disappear, and glandular enlargements are often dispersed. It also usually relaxes the bowels, in consequence of the augmented secretion of their mucous membrane.

In larger doses, mercury acts as a *sialogogue*, producing all the above-mentioned effects, only to a greater degree, and in addition, increased action of the salivary glands, with swelling and soreness of the gums—a train of symptoms denominated *salivation*. The signs of the mercurial sore mouth are the following: slight swelling and tenderness of the gums, particularly when the teeth are pressed together; a coppery taste in the mouth; a peculiar, unpleasant breath; and an increased flow of saliva, which may become excessive. During this state, the fat is rapidly absorbed, the patient becoming emaciated; the nervous and circulatory systems are excited, and the blood, when drawn, exhibits the same appearance as in inflammation.

On some constitutions, mercury produces a sort of poisonous effect, causing great prostration, a small and frequent pulse, with a pallid and contracted countenance. It sometimes occasions an eruption upon the skin of a miliary character, and in some instances, gives rise to profuse sweats. The remedy for these effects is pure fresh air, and a tonic course of treatment.

Mercury produces its influence upon the system, in consequence of being absorbed, as is proved by the fact of its being detected in several of the secretions, as well as in the solids.

Uses.—1. *As an alterative.*—In *functional disorder of the digestive organs*, as indicated chiefly by the appearance of the stools, which are either scanty, dry, and of a clay colour, showing a deficiency of bile, or very copious, liquid, and of a bilious colour, showing a redundancy of bile;—in *constipation*, which very often depends on a deficient hepatic secretion, or deficient secretion of the intestinal mucous membrane;—in *some forms of chronic cutaneous disease.*—*Dose*,—as an alterative, half a grain to a grain of calomel, or three grains of blue mass, every night, or every other night, to be followed next morning with a laxative, if the bowels are confined. In acute cases, much smaller doses may be given, and more frequently repeated.

2. *As a sialogogue.*—In *fevers*, mercury is very useful; chiefly in exciting the secretions. The proper indications for its use are a dry tongue, torpor of the bowels, dry skin, and scanty urine; it is an important remedy in typhoid fever; but here the *mildest* salivation is only required. In very high grades of fever, it is almost impossible to salivate.—In *inflammation*, it is a valuable therapeutic agent, acting as a true antiphlogistic or antiplastic, preventing the formation of coagulable lymph, more particularly where the serous membranes are involved; generally, bloodletting should be premised: it is contra-indicated in inflammations of an erythematous, gangrenous, malignant, or

scrofulous character.—In *diseases dependent on disordered secretion of the liver*, as dysentery, diarrhœa, ascites, &c.—*To promote absorption*, as in the various forms of dropsies. To produce what has been termed its *revolutionizing effect*, in certain specific diseases, especially syphilis, but only in its secondary form; also, in colica Pictonum, in which it may be usefully combined with opium.

It is contra-indicated in scrofula, phthisis, all malignant diseases, and suppurations. *Dose*, as a salivant, half a grain to a grain of calomel, or 3 to 5 grs. blue pill, three times a day: opium to be added, if it purge. If the stomach be irritable, the mercurial ointment may be rubbed on the insides of the arms and thighs, or applied to blistered surfaces; or fumigations with cinnabar may be resorted to.

There is a great difference in the susceptibility of different persons to the salivant action of mercury; it is much more difficult to salivate children than adults. Sometimes the medicine accumulates in the system, and breaks out with great violence.

In producing salivation, the mildest impression is all that is required; excessive salivation is always to be avoided. The treatment for it is to reduce the local inflammation by leeches and blisters, if necessary; astringent and detergent washes of alum, sugar of lead, &c., and opium internally.

Preparations of Mercury.—It is not, at present, given in the liquid form. When given in the metallic state, it is *extinguished*, by being first rubbed up with different substances, which serve to divide it very minutely, and perhaps, partially to oxidize it.

Mercurial or Blue Pills. (*Pilulæ Hydrargyri*, U. S.)—Made by rubbing up metallic mercury with conserve of roses and liquorice-root;—requires a long trituration. Colour, bluish; becomes darker by exposure; weight of the officinal pill, three grains. Dose, as a sialogogue, one pill, three times a day; as an alterative, one pill, every other night;—sometimes given in emulsion.

Mercury with chalk. (*Hydrargyrum cum Cretâ*, U. S.)—Prepared by triturating mercury with prepared chalk; colour, bluish-gray; a mild mercurial, particularly useful in the bowel-affections of children. Dose, from 1 to 10 grs., three or four times a day.

Mercurial Ointment. (*Unguentum Hydrargyri*, U. S.)—Sometimes called *blue ointment;* prepared by rubbing up together mercury, lard, and suet, until the mercury is extinguished; colour, bluish; becomes darker by age; used to produce the mercurial impression, by rubbing into the skin; also to blistered surfaces.

Mercurial Plaster. (*Emplastrum Hydrargyri*, U. S.)—Made by rubbing up mercury with melted rosin and oil, and then mixing with melted lead-plaster; used to discuss glandular swellings, &c.

Mild Chloride of Mercury. (*Hydrargyri Chloridum Mite*, U. S.)—Chemically, a *protochloride;* common name, *Calomel.* Made by subliming a mixture of the protosulphate of mercury and chloride of

sodium; double decomposition ensues, resulting in the formation of protochloride of mercury and sulphate of soda; crystalline at first; requires to be powdered and washed in water; colour, ivory-white; no taste or smell; insoluble in water or alcohol; incompatibles, alkalies, alkaline earths, and sulphurets. Dose, as a sialogogue, gr. ss to gr. j, three times a day; as an alterative, gr. j, every night, or every other night. *Howard's calomel* is a very fine variety, made by allowing the vapour to come in contact with watery vapour.

Corrosive Chloride of Mercury. (*Hydrargyri Chloridum Corrosivum*, U. S.) — Common name, *Corrosive Sublimate;* chemically, a *bichloride;* made, by subliming a mixture of the bisulphate of mercury and chloride of sodium. At first, it is in white, semi-transparent masses; soluble in water and alcohol; taste, metallic and styptic; very poisonous; best antidote is albumen; not much used internally; not so liable to salivate as calomel; externally applied, it is escharotic; a weak solution, or ointment, is employed in venereal sore throat, and cutaneous diseases.

Black Oxide of Mercury. (*Hydrargyri Oxidum Nigrum*, U. S.) — Chemically, a *protoxide;* made by adding calomel to lime-water, or a solution of potash; colour, black; used chiefly as a wash for chancre, in the form of *black wash.* Dose, ¼ gr.

Red Oxide of Mercury. (*Hydrargyri Oxidum Rubrum*, U. S.)— Chemically, a *binoxide;* common name, *red precipitate;* made by heating the nitrate; occurs in small, shining, red crystals; never used internally; but externally, as a stimulant for old and indolent ulcers; also, for psorophthalmia, in the form of ointment.

Iodide of Mercury. (*Hydrargyri Iodidum*, U. S.)—Chemically, a *protiodide;* made by rubbing up mercury and iodine together with alcohol; colour, greenish-yellow; used in secondary syphilis; dose, one grain, gradually increased.

Biniodide of Mercury. (*Hydrargyri Iodidum Rubrum*, U. S.) — Prepared by action of corrosive sublimate on iodide of potassium; colour, brilliant red; used as an ointment in skin diseases.

Red Sulphuret of Mercury. (*Hydrargyri Sulphuretum Rubrum*, U. S.) — Common name, *Cinnabar;* found native; made by heating together mercury and sulphur; colour, fine red; powder is called *vermilion,*—used for fumigation.

Black Sulphuret of Mercury. (*Hydrargyri Sulphuretum Nigrum*, U. S.) — Old name, *Ethiops mineral;* prepared by rubbing sulphur and mercury together in a mortar; colour, black: scarcely ever used at present.

Yellow Sulphate of Mercury. (*Hydrargyri Sulphas Flavus*, U. S.) Common name, *Turpeth mineral;* made by the action of boiling water on the bisulphate; the yellow subsulphate precipitates; very little used; emetic, in the dose of 5 grains.

Nitrate of Mercury. (*Hydrargyri Nitras*, U. S.) — Used only in the form of ointment, — called *citrine ointment* (*Unguent. Hydr.*

Nitratis, U. S.), made by heating the fresh nitrate with lard and neat's-foot oil. This is of a fine citron colour, when first made, but spoils by being kept; much used in skin diseases, and as a stimulant to ulcers.

Ammoniated Mercury. (*Hydrargyrum Ammoniatum*, U. S.)—Common name, *white precipitate;* made by adding the solution of ammonia to a solution of corrosive sublimate; occurs in white masses, without odour; used only as an ointment for cutaneous diseases.

Iodine. (*Iodinium*, U. S.)—A simple, non-metallic solid, of a bluish-gray colour, and metallic lustre, with a peculiar odour; volatile; sparingly soluble in water; more so in alcohol.

Effects on System.—In very small doses, it acts as a general tonic, occasionally increasing the flow of urine, and sometimes producing salivation. If continued for a length of time, it stimulates the absorbents, causing emaciation. If still longer employed, it acts upon the nervous system and digestive organs. In large doses, it is a corrosive poison. Used chiefly to promote the absorption of indurations and enlargements, &c. Probably, the best remedy in goître, in which it may be employed both internally and externally. Scrofula is another disease in which iodine acts beneficially, particularly in the form of glandular swellings, ophthalmia, abscesses, &c.; valuable in every form of tuberculous disease, also in chronic rheumatism, chronic cutaneous diseases, and tertiary syphilis. Dose $\frac{1}{4}$ to $\frac{1}{2}$ a grain, but not in substance, on account of its difficult solubility.

Tinctura Iodinii, U. S.—Contains ℥j of iodine to Oj alcohol; not quite saturated; when long kept, it is partially decomposed; dose, 10 to 20 drops, in sweetened water. The tincture used advantageously, externally, in frost-bite, lupus, erysipelas, and other skin diseases; and also in affections of the joints; to be applied by means of a small brush. Iodine is also employed externally, dissolved in collodion, of the same strength as the tincture.

Compound Tincture of Iodine, (*Tinct. Iodidii Composita*, U. S.), contains ℥ss of iodine, ℥j of iodide of potassium, and Oj of alcohol.

Iodide of Potossium. (*Potassii Iodidum*, U. S.)—Made by mix ing together iron filings and iodine with water, by which iodide of iron is formed; then decomposing with carbonate of potassa. It is in the form of white cubical crystals; somewhat deliquescent; very soluble in water and alcohol; taste, acrid and saline; its aqueous solution has the property of dissolving iodine. It acts on the system very much as iodine, though less energetically;—used in cachectic conditions, particularly in tertiary syphilis; in the various forms of scrofula, rheumatism, &c. Dose, 3 to 20 grs., three times a day. Sometimes it produces some irritation of the bowels, and vertigo.

Lugol's Solution of Iodine. (*Liquor Iodinii Compositus*, U. S.)—Made by dissolving ℥jss iodide of potassium and ʒvj iodine, in Oj water; dose, 6 to 30 drops, three times a day, gradually increased.

This is an active and excellent preparation, much used by Lugol in the treatment of scrofula.

There are many other preparations of iodine, more or less employed; as the *iodide of lead; iodide of sulphur*,—used in the form of an ointment, in certain cutaneous affections;—*iodide of zinc*, &c.

Iodine Ointment. (*Unguentum Iodinii*, U. S.)—Made by rubbing up together iodine and lard.

Unguentum Iodinii Compositum, U. S.—Made like the other, with the addition of some iodide of potassium; both are used in indolent scrofulous tumours.—Iodine and iodide of potassium are sometimes employed in the form of bath.

ARSENIC. (*Arsenicum*, U. S.)—Probably inert, so long as it retains its metallic state; but very active, as an oxide, or salt.

Effects.—In very minute doses, it is tonic and alterative; but, if persisted in, it causes muscular debility and general depression of the system. It acts by being absorbed into the blood, as is proved by its existence in the secretions. In large doses, it is a powerful corrosive poison. Symptoms of poisoning—pain and heat of stomach, pain of throat, vomiting of acrid matters, incessant thirst, prostration, and death. Antidote—the *hydrated peroxide of iron*, which acts chemically, forming an insoluble arsenite of iron.—Used chiefly in intermittent diseases; will often cure intermittent fever, when quinine fails; also, in chronic skin diseases, particularly of a scaly character; also in nodes. Dose of arsenious acid, $\frac{1}{12}$th of a grain, three times a day, in pill.

Fowler's Solution. (*Liquor Potassæ Arsenitis*, U. S.)—Made by boiling together 64 grs. arsenious acid and carbonate of potassa, each, in f℥xij water, and then adding fʒss spirits of lavender, to impart a colour. Dose, 10 drops; but often this will be found too much for some constitutions.

The arsenical preparations should be given on a full stomach, and their effects very carefully watched. One of the first symptoms of the system being brought under their influence, is an œdema of the eyelids, which will subsequently spread over the face.

LOCAL REMEDIES.

CLASS X.

EMETICS.

MEDICINES which, as an ordinary result, produce vomiting. The effect of an emetic is not immediate; usually from 10 to 20 minutes

elapse before vomiting occurs. Emesis is partly the act of the stomach, and partly of the brain and spinal marrow; if the brain be stupified by narcotics, the stomach becomes very insusceptible to the action of emetics. Some emetics act only if *immediately* applied to the stomach; others produce their effect no matter how introduced into the system. The act of vomiting is chiefly *reflex*. If the eighth pair of nerves be cut, no vomiting is produced by emetics. The susceptibility to their influence is increased by irritation or inflammation of the stomach, and by fever; it is lessened by nervous disorders, and by narcotic poisons.

Emetics are useful to remove improper matters from the stomach, as poisons or ingesta; to deplete from the system; to promote the secretions; to produce muscular relaxation; to give a shock to the system, and thus break up morbid associations; to cause pressure on the surrounding viscera; to reduce arterial action; and to cause revulsion to the stomach. They should be avoided, if possible, in congestion of the brain, hernia, the advanced stages of pregnancy, and in inflammation of the stomach and surrounding parts.

Ipecacuanha, U. S.—Root of the *Cephaëlis ipecacuanha*, a perennial plant, growing in Brazil; about 5 or 6 inches high. The roots, as met with in the shops, are several inches long, contorted, of

Fig. 356.

a grayish-brown colour, about the thickness of a small quill, apparently composed of a series of transverse rings, from which cause it is often called *annulated*. The cortical portion, which includes the rings, is hard, horny, and brittle, resinous in its fracture; the lig-

neous portion is small and inert. There are three varieties, *brown*, *red*, and *gray*. Colour of powder, light fawn; odour, slight in mass. The powder excites sneezing, and, in some, asthmatic symptoms. Water and alcohol extract its virtues; but injured by long boiling; also by exposure to the light. Active principle, an alkali called *emetia*.

Uses.—In very small doses it is tonic and alterative; rather larger doses prove diaphoretic and expectorant; still larger quantities cause vomiting. Its emetic operation is mild, prompt, and certain; hence it is very useful as an evacuant from the stomach. It has been used with advantage in hemorrhage.—Dose, as an alterative, ¼ to ½ gr.; as a diaphoretic, ½ to grs. ij; as an emetic, 15 to 30 grs.; best given in warm water.

The *Vinum Ipecacuanhæ*, U. S., contains ℥j to Oj;—dose, as an emetic, f℥j,—for an adult. Used chiefly as a diaphoretic and expectorant.

The *Syrupus Ipecacuanhæ*, U. S., is of about the same strength.

There are several indigenous emetics, the most important of which are the following:

Gillenia, U. S.—Root of the *G. trifoliata* and *G. stipulacea*. It is sometimes called *Indian physic*. It has a long, branching root, of a reddish-brown colour. Dose of powder, 20 to 30 grs. A good substitute for ipecacuanha.

Euphorbia Ipecacuanha, U. S. (*American Ipecacuanha*), and E. Corollata, U. S. (*Large Flowering Spurge*), are very irritant and powerful emetics, especially in the fresh state. They are not much employed on account of the uncertainty of their operation, and their liability to purge. Dose, gr. x–xxx.

Lobelia, U. S. (*Indian Tobacco.*)—Herbaceous part of the *L. inflata*, an annual plant. Along with its emetic properties it is also narcotic, producing very much the effects of tobacco. Used chiefly in spasmodic asthma. Dose, 5 to 20 grs. The *tincture* is officinal;—dose, f℥j; repeated if requisite.

Sanguinaria, U. S.—Root of the *S. Canadensis*, or *blood-root*; distinguished by its red colour, and truncated appearance. Emetic, and slightly narcotic; also used in catarrhs. Dose, 10 to 20 grs.;—of tincture, f℥ij to f℥ss.

Squill and *Tobacco* are emetic in large doses, but are seldom employed for this purpose; the great prostration produced by the latter is an objection.

Mustard, in powder, is a stimulant emetic; it may be used in some cases of narcotic poisoning.

MINERAL EMETICS.

Tartar Emetic differs in its action, as an emetic, from ipecacuanha, in causing much more retching, nausea, and general disturbance of the system; hence employed to act upon the surrounding viscera, as in congested liver or spleen; to break up the paroxysms of intermittents; to produce relaxation in croup, and in dislocations; in nervous diseases, as in neuralgia and amaurosis. Ipecacuanha is preferable in poisoning from narcotics. Often combined with ipecacuanha. Dose, 2 or 3 grs.; best given in divided quantities, dissolved in water. Dose of *Vinum Antimonii* as an emetic, f℥j, repeated, for an adult.

Sulphate of Zinc.—A very prompt and powerful emetic, causing but little nausea. Chiefly used in cases of narcotic poisons,—best to combine it with ipecacuanha. Dose (medium), gr. x; in narcotic poisoning, gr. xx–xxx.

Sulphate of Copper.—A still more powerful emetic than the last; —used also in narcotic poisoning;—sometimes in membranous croup. Medium dose, 2 or 3 grs.; in cases of poisoning by narcotics, 5 to 15 grs.;—danger of inflammation from over-doses.

The *Turpeth Mineral*, *Arsenic*, and *Corrosive Sublimate*, are each emetic in large doses, but are scarcely ever used with this intention. *Alum* is occasionally employed.

CLASS XI.

CATHARTICS.

These are medicines which evacuate the alimentary canal. They act either, 1, by increasing the peristaltic movement, or 2, by augmenting the mucous secretions, or 3, by stimulating the liver to throw out bile. Such cathartics as merely evacuate the intestinal contents, are termed *Laxatives;* those which produce increased secretion into the bowels, *Purgatives;* and such as cause large watery discharges, *Hydragogues*. Cathartics also differ as to the part of the canal which they affect; thus aloes chiefly acts upon the rectum; gamboge and calomel upon the upper bowels; the neutral salts upon the whole tract. Some occasion a great amount of depletion, while others, as rhubarb, produce a tonic impression. The term *drastic* is applied to such as act with great violence.

Uses.—To evacuate the bowels from noxious matters; to relieve constipation and its attendant evils; to deplete from the system; to promote absorption, in dropsies; to cause revulsion to the bowels, par-

ticularly in cerebral disorders. They are contra-indicated in inflammation of the mucous membrane of the bowels; and should be cautiously employed in typhoid fever. Their activity is increased by the addition of small quantities of emetics and bitters. Their griping effect is best obviated by combination with aromatics or opium. They act most powerfully when taken in an empty stomach. Hypercatharsis is best checked by an anodyne enema.

There are several *articles of diet* which are laxative, and may be usefully employed in medicine, such as the ripe fruits in their fresh state, or the same dried and stewed,—particularly peaches, prunes, and tamarinds. Sugar is also laxative, particularly in the form of *West India molasses*. *Rye* or *oatmeal mush and molasses* form an excellent article of diet in habitual costiveness, and in hemorrhoids. Sugar is apt to disagree with the stomach of dyspeptics, on account of its liability to generate an acid. *Bran* is an excellent article of diet in dyspepsia and constipation; believed to produce its laxative impression by mechanical irritation; best used in the form of *bran-bread*, made from the unbolted flour.

PURGING CASSIA. (*Cassia Fistula*, U. S.)—Fruit of the *C. fistula*, a tree growing in the East and West Indies; consists of pods about a foot in length, containing numerous seeds surrounded with a black, sweetish pulp. The *pulp* is procured by bruising the pods, and boiling in water. It is a mild laxative, and forms one of the ingredients in the Confection of Senna. Dose ʒj to ℥j.

MANNA, U. S.—Concrete juice of the *Ornus Europæa*, a tree growing in Southern Italy and Sicily. Procured both by spontaneous exudation and incisions. Three varieties found in commerce. 1. *Flake Manna*, the result of spontaneous exudation; comes in pieces two or three inches long, about an inch wide, bearing the marks of the bark, &c., on which it has concreted; colour, yellowish-white; odour, faint; taste, sweetish. 2. *Common Manna*, or *Manna in sorts*, procured, when the season is more advanced, by incisions; consists of particles of the flake, mixed with a fluid portion and impurities; colour, darker; inferior. 3. *Fat Manna*, obtained still later in the season; consists chiefly of the fluid portion, with numerous impurities; colour, much darker. Manna consists of a resinous matter, united to a peculiar saccharine principle, called *mannite*.

Uses.—A mild laxative, adapted to cases of constipation, hemorrhoids, and pregnancy; also to children. Dose ℥ss to ℥ij.

CASTOR OIL. (*Oleum Ricini*, U. S.)—Product of the *Ricinis communis*, or Palma Christi (Fig. 357), growing in various parts of the world. As found in the United States, it is an annual. The fruit is a three-celled capsule, each cell containing an oblong, spotted, brownish seed. The seeds are powerfully purgative, in consequence of an acrid principle which they contain, and which is dissipated by a high

heat. The oil is procured either by expression or decoction. 1. *Expression.* The seeds are gently heated, and then subjected to powerful pressure; a thick, whitish oil exudes, which is boiled for some time in a large quantity of water; this dissolves out the mucilage, and coagulates the albumen; the clean oil is now removed, and boiled with a minute quantity of water, to drive off the acrid principle. 2. *Decoction.* The seeds are bruised and boiled in water; the oil rises and is skimmed off the surface, and is again boiled to remove the acrid principle; apt to have a darker colour than the other. The acrid principle is thought to consist of two peculiar fats, termed ricinolein and ricinomargarin.

Fig. 357.

Uses.—A mild and certain cathartic, intermediate in its action between laxatives and purgatives. The more it is free from colour, smell,

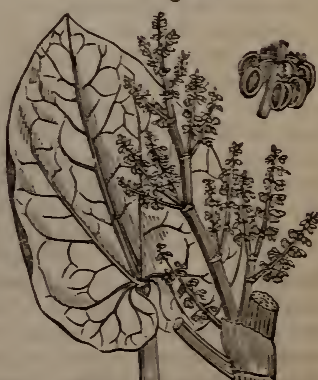
and taste, the better; soluble in cold alcohol; particularly applicable to cases of children and pregnant women; also in irritated and inflammed bowels, colic, dysentery, and diarrhœa. Ordinary dose f℥j, though less will frequently operate. Infants require a larger proportionate dose than adults, in consequence of their digesting it. May be given in boiling milk, hot coffee, &c.; but best in the froth of porter or ale; also as an emulsion.

Linseed oil, almond oil and *melted butter* may be substituted for castor oil.

Fig. 358.

Fig. 359.

Fig. 360.



RHUBARB. (*Rheum*, U. S.)—Root of different species of *Rheum*, as *R. palmatum* (Fig. 358), *R. undulatum* (Fig. 359,) *R. compactum* (Fig. 360), &c., growing in Tartary and other parts of Asia; also cultivated in Europe. The precise variety which yields Asiatic rhubarb

is, however, unknown. It is a perennial plant, with large branching roots and numerous large petiolate leaves.

The roots, when dug up, are carefully dried, sorted, and sent to market. Three varieties are recognised: 1. *Russian* or *Turkey Rhubarb.* This kind is prepared with extreme care, at a frontier town between Tartary and Russia, each piece being bored down to its centre to ascertain its soundness: imported from St. Petersburg. The pieces are irregularly cylindrical in shape, with angular edges, of a lively yellow colour externally, variegated within; yields before the knife, feels gritty to the teeth, stains the saliva, and has a bitter and astringent taste; it is the most valuable. 2. *Chinese Rhubarb.* Probably of similar origin with the other; shipped from Canton; the pieces are smooth and powdery on the outside, appearing as if rasped. Colour, not so lively; odour and taste, similar to the other; the perforation extends quite through, and sometimes presents the remains of the string upon which it was dried; inferior in value, but much cheaper. 3. *European Rhubarb.* — Comes in long thin pieces, or roundish pieces less compact; does not tinge the saliva, nor feel gritty to the teeth; inferior to the others as a purgative.

Active principles, *crysophanic acid,*—a yellow, crystalline, volatile substance; and also three resins, tannin, oxalate of lime, an odorous principle, colouring matter, &c. Water and alcohol extract its virtues; it should not be long boiled.

Uses.—A good tonic cathartic, operating chiefly on the peristaltic motion; in small doses astringent; does not deplete, and hence the best purgative in typhoid cases. Much used in constipation, combined with aloes and soap. It sometimes gripes, in which case it may be combined with aromatics. Dose, as a laxative, 5 to 10 grains; as a purgative, 20 to 30 grains; given in powder or pill. The following are the officinal preparations; *Infusum Rhei,* made in proportion of ℥ij to Oj water; *Tinctura Rhei,* useful in typhoid complaints; *Tinct. Rhei et Aloes,* formerly called *Elixir Sacrum; Tinct. Rhei et Sennæ,* or *Warner's Gout Cordial; Syrupus Rhei; Syrupus Rhei Aromaticus,* or *Spiced Syrup of Rhubarb; Syrupus Rhei et Sennæ; Vinum Rhei; Extractum Rhei; Extractum Rhei Fluidum; Pilulæ Rhei; Pil. Rhei Compositæ.*—Roasting impairs the purgative property of rhubarb, but does not affect its astringency.

Aloes. (*Aloe,* U. S.)—Inspissated juice of the leaves of different species of *Aloe,* as *A. spicata, A. Socotrina,* and *A. vulgaris,*—succulent plants with long, narrow, toothed leaves, growing in tropical countries. The juice is procured either by draining from the leaves, by expression, or by boiling. Several varieties recognised in commerce: 1. *Cape Aloes.* Obtained from the *A. spicata,* growing at the Cape of Good Hope; occurs in masses of a shining, dark olive-green colour, of a vitreous fracture, translucent at the edges; powder, of a greenish-yellow colour; odour, disagreeable; taste, intensely and

permanently bitter. 2. *Socetrine aloes,*—from the *A. Socotrina;* pieces of a yellowish-brown colour, less shining than the former; fracture conchoidal; odour, aromatic; taste, very bitter; much the most valuable variety. 3. *Barbadoes aloes,*—prepared in the West Indies; the product chiefly of the *A. vulgaris;* colour dark-brown, not shining; odour, disagreeable; much used for horses. 4. *Hepatic aloes,*—known in India as *Bombay aloes;* probably an inferior variety of Socotrine and other sorts; it has a dark liver colour.

Aloes consists of a peculiar soluble matter, termed *aloesin,* and an insoluble substance called *apotheme.* It yields its virtues to water and alcohol.

Uses.—A warm purgative, slow in its operation, acting on the lower bowels; will sometimes produce piles, if too long continued; it also has a tendency to the pelvic viscera generally; chiefly given in constipation, combined with soap, rhubarb, or colocynth. Dose, as a laxative, 2 to 6 grs.; as a purgative, 10 to 15 grs. The officinal preparations are the following: *Pilulæ aloës et assafœtidæ,* very useful in the constipation of old people; *Pilulæ aloës et myrrhæ,* or *Rufus' Pills; Pil. Rhei compositæ; Pulvis aloës et canellæ* or *hiera picra; Tinctura aloës; Tinc. Aloes et myrrhæ,* or *elixir proprietatis; Vinum aloes.*

Senna, U. S.—Leaflets of different species of *Cassia,* as the *C. acutifolia* (Fig. 361), *C. obovata, C. elongata, C. Æthiopica,* small

Fig. 361.

shrubs growing in tropical Asia and Africa. Several commercial varieties: 1. *India senna,* the product of the *C. elongata,* grown in Arabia and Africa, and thence taken to India; leaflets long and narrow, intermingled with pieces of pods. 2. *Tinnivelly senna;* probably from the same source as the preceding, but less broken

and more distinct; very free from impurities, and highly esteemed. 3. *Alexandria senna*, product of the *A. obovata* and *A. acutifolia*, derived from Upper Egypt. 4. *Tripoli senna*, from the *C. Æthiopica*,—seldom now found in market.

The true senna leaves may be recognised by their oblique lower edges, and the inequality of their insertion into the footstalk; odour, faint, but peculiar; taste, sweetish and nauseous; active principle, *cathartin.*

Senna is an active hydragogue cathartic; generally administered in combination with manna, or the neutral salts. *Infusion* (*Infusum Sennæ*, U. S.) made in the proportion of ℥j to Oj. Its griping tendency obviated by combining with aromatics, or the neutral salts.—The following preparations are officinal: *Tinctura Sennæ et Jalapæ*, or *Elixir salutis; Confectio Sennæ*, or *Lenitive electuary; Syrupus Sennæ;* and *Fluid extract of senna.*

The leaflets of the *American Senna* (*Cassia Marilandica*, U. S.), an indigenous plant, possess similar properties to those of the true senna, and may be advantageously used as a purgative, in a rather larger dose.

Scammony. (*Scammonium*, U. S.)—Dried juice from the root of the *Convolvulus scammonia*, a climbing plant, growing in Syria and Asia Minor. It is obtained by slicing off the root, and allowing the juice to concrete. Formerly, the commercial varieties were distinguished as *Aleppo*, *Smyrna*, and *Montpellier* scammony; at present, they are generally known under the two heads of *genuine* and *factitious.* The purest kind is denominated *virgin* or *tear scammony;* it consists of shapeless masses, rather porous, of a dull ash colour, and free from impurities. The sort usually met with is in saucer-shaped pieces, three or four inches in diameter, of a dark ash-gray colour, hard, and containing numerous adulterations. It is often common to designate the genuine drug, from whatever source procured, as *Aleppo scammony;* while the term *Smyrna scammony*, is applied to the others. The *spurious* or *factitious* scammony, is chiefly manufactured in the south of France. Odour peculiar, resembling old cheese; taste acrid and bitter; chemically, a gum-resin, the *resin* being the active portion.

Effects.—A drastic cathartic; over-doses cause irritation and inflammation of the bowels; seldom given alone. Dose, five to ten grs.;—an ingredient in the *Compound extract of colocynth.*

Jalap. (*Jalapa*, U. S.)—Tuber of the *Ipomœa Purga* (Fig. 362), a climbing Mexican plant. The tubers are imported either whole or sliced. They vary from the size of a walnut to that of an orange; externally, of a blackish-gray colour, heavy, hard, and of a brownish fracture; odour peculiar and nauseous; taste nauseous; colour of powder, light brown. The root is apt to be adulterated. Virtues

imparted partly to water, and partly to alcohol. Active ingredient is a resin; it contains also much starch, and some gum and sugar.

Effects. — A powerful hydragogue cathartic; much used in dropsies and chronic affections of the joints, particularly in combination with cream of tartar. Dose, 15 to 30 grs.; dose of calomel and jalap, 10 grs. of each, — used in bilious complaints; dose of jalap and crem. tartar, 10 to 20 grs. of the former, and 2 to 4 drachms of the latter.

Fig. 362.

The *Resin of Jalap* is the alcoholic extract: dose 8 to 10 grs. *Extract of Jalap* is used in doses of 10 to 20 grs.; the *tincture* is also officinal. The *Pulvis Jalapæ Compositus*, U. S., is a mixture of one part of jalap and two parts of cream of tartar.

The May Apple (*Podophyllum peltatum*, U. S.), an indigenous perennial plant, possesses very similar medical properties to those of jalap. The root, which is the part used, is very long and branching, of a brownish colour externally. It contains two resins, both cathartic. It may be employed in the same cases as jalap. Dose, the same. The *extract* is officinal.

Colocynth. (*Colocynthis*, U. S.)—Fruit of the *Citrullus colocyn-*

Fig. 363.

this, or *Bitter cucumber*, a vine resembling the common cucumber, growing in the South of Europe, Asia, and Africa. Fruit about the size and shape of an orange; has a yellow rind, and a white, light, and porous pulp, containing numerous seeds. As found in the shops, it is usually divested of the rind. Taste, extremely bitter; virtues to water and alcohol; the infusion gelatinizes on cooling in consequence of the *pectin* contained; active principle, *colocynthin*.

Effects. — A powerful hydragogue, producing in over-doses inflammation of the bowels. Not much used alone. — Dose, 5 to 10 grs. The *compound extract* (*Extractum Colocynthidis Compositum*, U. S.), is an excellent cathartic; it contains colocynth, aloes, scammony, soap, and cardamom;—dose, 10 to 15 grs.

Black Hellebore. (*Helleborus*, U. S.)—Root of the *Helleborus niger*, growing in the southeast part of Europe. Sometimes called the *Christmas rose.* The root, as found in the shops, consists of a knotted caudex, from which proceed numerous black fibres, smooth and brittle; odour, slight; taste, bitter and nauseous; becomes much feebler by being kept; virtues to alcohol and water.

Effects.—A drastic hydragogue, also emmenagogue; much used by the ancients in mania; not so much employed at present. It is sometimes named *Melampodium.* Dose, 10 to 20 grs.; — of the *tincture* (*Tinc. Hellebori*, U. S.) f ʒj; of the *extract* (*Extractum Hellebori*, U. S.) gr. iij–v.

Gamboge. (*Gambogia*, U. S.)—Inspissated juice of an undescribed tree of Siam, and of the *Hebradendron cambogioides*, a native of Ceylon. The juice is procured by breaking off the leaves and young shoots; at first it is of a yellow colour, but becomes a dark orange by hardening. Usually found in cylindrical pieces, many of which are hollow. Fracture glossy; colour of powder, bright yellow; no odour, and but slight taste; forms with alcohol a golden-coloured tincture, and with water a yellow turbid emulsion.

Effects.—A powerful drastic cathartic; over-doses dangerous. Dose, 3 to 6 grs., usually given in dropsy, combined with cream of tartar; also in tape-worm.

Compound Cathartic Pill. (*Pilulæ Catharticæ Compositæ*, U. S.) — An admirable compound cathartic, containing calomel, scammony, gamboge, colocynth, aloes, and jalap; dose, for an adult, three pills.

Croton Oil. (*Oleum Tiglii*, U. S.) — Derived from the seeds of the *Croton tiglii*, a small tree growing in the East Indies. The oil is procured by first roasting the seeds and then subjecting them to pressure. As first obtained it is nearly colourless; but as found in the shops, it has a yellowish-red hue; odour, faint and peculiar; taste, acrid and burning; partially soluble in alcohol, which separates it into its constituent portions; of these, the acrid principle, called *crotonic acid*, is soluble, while the true oil, which is a mild fixed oil, is

not soluble. Most liable to be adulterated with castor oil; fraud detected by the solubility of the latter in alcohol.

Effects. — One of the most powerful drastic cathartics; over-doses very dangerous; applicable in obstinate constipation, and in coma; advantage from the smallness of the dose. Dose, 1 to 3 drops, best given in form of pill made up with crumb of bread, each containing half a drop. Applied externally, it produces a pustular eruption, and may be used as a revulsive, in diseases of the chest, &c.; it should be mixed with olive oil. Its external irritant effect varies much in different persons.

ELATERIUM, U. S. — Product of the *Momordica elaterium*, or *squirting cucumber* (Figure 364), a vine growing in the South of Europe. The fruit is about the size of a lime, oval, of a greenish colour, and covered with numerous prickles. When ripe it bursts, projecting its contents. Elaterium is procured by slicing the fruit, and the juice allowed slowly to drain away upon a muslin sieve, when it gradually deposits the medicine. This is in small flattish pieces, of a grayish-green colour, light and friable; has no odour, but a bitter and nauseous taste; active ingredient, *elaterin*.

Fig. 364.

Effects.—Probably the most active of all cathartics. Used chiefly in obstinate dropsy. Dose of the purest (Clutterbuck's), $\frac{1}{8}$ gr.; of the commercial, $\frac{1}{2}$ gr.; dose of *elaterin*, $\frac{1}{16}$ to $\frac{1}{12}$ gr. Always best to commence with very small doses, from the uncertainty of the preparation.

MINERAL CATHARTICS.

SULPHUR, U. S.—Used in medicine in the form of *flowers of sulphur*, or common sublimed sulphur washed in water (*Sulphur Lotum*, U. S.). Odour and taste slight; insoluble in water, and nearly so in alcohol; soluble in oils.

Effects.—A mild laxative, but slow in its operation, sometimes griping; it has a decided tendency to the skin, and is thought to act on the bronchial mucous membrane. It is used in constipation attended

with piles, in combination with cream of tartar; also, in dyspepsia, chronic rheumatism, chronic catarrhs, and cutaneous eruptions. Dose as a laxative, ʒj to ʒij. Externally, an excellent remedy for scabies, in the form of *sulphur ointment;* also, in the form of vapour and bath. The bath is best in the form of the natural sulphur waters.

Sulphur Præcipitatum, U. S., *lac sulphuris, milk of sulphur*—made by boiling together sulphur and lime, and then adding muriatic acid, which precipitates the sulphur in the form of a hydrate; colour, nearly white, but darkens by exposure. It has no advantage over the other form.

Calomel.—As a cathartic, it is indicated in cases where the liver is deficient in action, or is secreting vitiated bile. It is slow in its operation, requiring six or eight hours. It is apt to produce nausea and griping some time after being taken, which are no doubt owing to the bile poured out. It is believed to act by being absorbed directly into the vena porta, and so finding its way into the liver. Ordinary dose, 5 to 15 grains, but best to combine it with other purgatives, as rhubarb or jalap. There is a great difference in the susceptibility of different persons to its action. It is one of the ingredients in the *Compound Cathartic Pills.*

Magnesia.—Sometimes called *calcined magnesia,* and *magnesia usta.* Procured by exposing the carbonate to a red heat. A very light white powder; its degree of levity, however, depends upon its amount of trituration, its density being increased by that process. In this way the magnesia of Henry, Husband, &c., is made; almost insoluble in water.

Effects.—A mild and useful cathartic, particularly when there is acidity in the primæ viæ. Its cathartic operation is somewhat uncertain, depending upon the presence of an acid: it sometimes accumulates in the bowels. It is also used in sick headaches, and in nephritic complaints; also, in bowel-complaints, combined with rhubarb. Dose ʒj;—best given rubbed up in syrup.

Carbonate of Magnesia. (*Magnesiæ Carbonas,* U. S.)—Prepared by decomposing any soluble salt of magnesia by an alkaline carbonate. Occurs in white cakes, extremely light and porous; insoluble in pure water; somewhat soluble in carbonic acid water.

Effects.—A gentle laxative, but dependent for its operation on the acid found in the stomach and bowels; apt to occasion flatulence from the escape of the carbonic acid. Dose, ʒj to ʒij.

SALINE CATHARTICS.

Nearly all are of mineral origin. They closely resemble each other in their operation upon the system, producing watery evacuations, from their influence over the secretory vessels of the mucous membrane. They are likewise refrigerant, and more or less antiplastic, and are

hence peculiarly adapted to febrile and inflammatory complaints, but are contra-indicated in typhoid disorders.

Solution of Citrate of Magnesia. (*Liquor Magnesiæ Citratis*, U. S.)—Made by adding carbonate of magnesia to a solution of citric acid and syrup; to be put into a strong bottle and corked before effervescence has ceased. It is a very agreeable cathartic. Dose, f℥ij–viij.

Epsom Salt. (*Magnesiæ Sulphas*, U. S.)—Procured from the bittern of sea-water after the crystallization of the chloride of sodium. A better method is by the action of sulphuric acid on magnesite; also from springs. As usually found, the crystals are small and needle-shaped; contain 50 per cent. of water of crystallization; effloresce slowly; very soluble in water; taste bitter and saline; sometimes contain sulphate of soda as an impurity. One of the best saline cathartics, and very extensively employed. Dose for an adult ℥j; best given in carbonic acid water.

Glauber's Salt. (*Sodæ Sulphas*, U. S.)—Procured as the residuum after making muriatic acid; also from the bittern of sea-water. Occurs in four-sided crystals; efflorescent; contain more than 50 per cent. water of crystallization; more soluble at 90° than 212°; taste, very nauseous and bitter; not so much used as Epsom salt;—dose about the same.

Sulphate of Potash. (*Potassæ Sulphas*, U. S.)—Formerly called *vitriolated tartar;* the residuum after the manufacture of nitric acid, from sulphuric acid on nitre; contains no water of crystallization; occurs in small, white, and very hard prismatic crystals; not very soluble; not much used as a cathartic, but chiefly in the preparation of Dover's powder. Dose, ʒss.

Tartrate of Potassa. (*Potassæ Tartras*, U. S.)—Formerly called *soluble tartar*. Prepared by adding cream of tartar to a hot solution of carbonate of potassa. The crystals contain no water of crystallization; they are deliquescent, have a cooling bitterish taste, and are very soluble in water;—not much used at present. Dose, ʒss to ʒj.

Cream of Tartar. (*Potassæ Bitartras*, U. S.)—Exists in the juice of grapes, from which it is deposited during the vinous fermentation, because it is insoluble in alcohol. It incrusts the sides of the wine casks, and is detached in the form of thick cakes of a reddish-gray colour, and sold under the name of *argol*. This, when properly purified, assumes the form of white transparent grains of pure cream of tartar. It is generally kept powdered. Taste, acid; soluble in sixty parts of cold water, and in fifteen of boiling water.

Effects.—A hydragogue cathartic; also diuretic and refrigerant. Very useful in dropsy; much employed, in combination with jalap, in chronic affections of the joints; and with sulphur in hemorrhoids.

Best given in sweetened water, or as an electuary with molasses; — dose, ʒss to ʒj.

Rochelle Salt. (*Sodæ et Potassæ Tartras*, U. S.) — Made by adding carbonate of soda to cream of tartar. Occurs in large, white, transparent, prismatic crystals of unequal sides; efflorescent; very soluble in water; taste less unpleasant than most of the others. It is one of the best of the saline cathartics. Dose ʒj to ℥iss.

The *Seidlitz powders* consist of a mixture of ʒij Rochelle salt, and ℈ij bicarbonate of soda in one paper, and 35 grs. tartaric acid in another paper; each paper to be dissolved in a separate tumbler, and the two mixed, when effervescence occurs from the escape of carbonic acid, and the patient swallows a mixture of Rochelle salt and tartrate of soda.

Phosphate of Soda. (*Sodæ Phosphas*, U. S.) — Prepared by the action of sulphuric acid on bone earth, which consists of carbonate and phosphate of lime; sulphate of lime is thrown down, and superphosphate of lime remains in solution; this is now to be decomposed by carbonate of soda. Occurs in large, rhombic, transparent crystals; very efflorescent; contain more than 50 per cent. of water of crystallization; taste resembles that of common salt; soluble in water; — dose, ʒj to ʒij. Particularly applicable to cases of children, but not much used on account of its expense.

ENEMATA.

Purgative injections are very useful, particularly to act on the lower bowels, and when there is irritability or inflammation of the stomach. The common *laxative enema* is composed of a table-spoonful of salt, molasses, and lard, each, with a pint of warm water; it may be rendered more active by the addition of castor oil, or the infusion of senna. Turpentine and assafœtida are useful in tympanites. Cold water alone is frequently employed in constipation. Large quantities of warm water are useful, by the mere distension produced.

CLASS XII.

DIURETICS.

Diuretics are medicines which increase the secretion of urine. Their action is much influenced by the external temperature, being promoted by cold, and diminished by heat. The two functions of the skin and kidneys are opposed one to the other, — whatever favours one secretion interfering with the other, and *vice versâ*. Their action is

also influenced by that of the bowels; free catharsis being always opposed to diuresis.

Diuretics may act, 1, either by being absorbed and coming into direct contact with the kidneys; 2, by promoting absorption into the blood-vessels; 3, by a stimulating impression on the mucous membrane of the urinary passages. Sometimes stimulant and tonic articles prove diuretic by the increased quantity of blood sent to the kidneys in a given time; certain mental emotions have also a powerful effect, as fear and anxiety.

They are used chiefly in dropsies, and in inflammations and irritations of the urinary organs, after proper depletion. As a class, they are rather uncertain in their action.

Diuretics may be divided into several classes, as the Saline, Alkaline, Acrid, and Sedative. Dr. Golding Bird makes two divisions, —*renal hydragogues*, or such as merely increase the watery portion of the urine, and *renal depurants*, or those which increase the solid constituents of the urine; the latter include the saline and alkaline diuretics.

SALINE DIURETICS.

Cream of Tartar. (*Potassæ Bitartras*, U. S.)—Exists in various vegetable juices, particularly that of the grape. Procured from wine casks during the vinous fermentation; the salt being insoluble in alcohol, is gradually deposited as a crust on the sides of the cask. In its crude form it constitutes the *argol* of the shops, of a reddish colour. Purified by repeated solutions. When pure, it is perfectly white, crystalline, has an acid state, more soluble in hot than cold water. It is an excellent hydragogue cathartic, and also diuretic. Well adapted to dropsies of an inflammatory type, from its possessing refrigerant properties. Should be given in a large quantity of cold water. Dose, ℥j to ℥ij daily.

Acetate of Potassa. (*Potassæ Acetas*, U. S.)—Prepared by action of distilled vinegar on carbonate of potassa. Very deliquescent, soluble in water and alcohol; formerly named *sal diureticus;* acts as a cathartic in large doses; produces diuresis in doses of ℈j to ʒj, every two or three hours, in a large quantity of water; used as the former.

Nitrate of Potassa.—Already spoken of under the head of refrigerants. Sometimes powerfully diuretic, especially when the surface is kept cool: used in the same cases as the two former. Dose, 10 to 20 grains, repeated, so that from ʒj to ʒij may be taken in twenty-four hours.

ALKALINE DIURETICS.

Carbonate of Potassa. (*Potassæ Carbonas*, U. S.)—Prepared from pearlash by dissolving in cold water, filtering, and evaporating,

at the same time stirring so as to cause it to granulate, the object of which is to expose as small a surface as possible to the air, and thereby prevent deliquescence. It contains impurities, as the silicate, sulphate, and muriate of potassa.

The purest carbonate, called *salt of tartar*, is made by heating two parts of cream of tartar with one of nitre.

Occurs in the form of small, white globules, of a nauseous, alkaline taste. It is a decided diuretic; used chiefly as an adjuvant, in dropsy accompanied with acidity of stomach; also as an antilithic in gravel. Dose, 10 to 20 grains, three or four times a day; may be given in carbonic acid water.

The *bicarbonate* (*Potassæ Bicarbonas*, U. S.) is prepared by passing carbonic acid through a solution of the carbonate. Occurs in white, flat prisms; inodorous; not so soluble as the carbonate.

Uses.—Same as the carbonate, but preferable on account of its more agreeable taste. Dose, ℈ss to ℈j, repeated.

STIMULANT DIURETICS.

SQUILL. (*Scilla*, U. S.)—Bulb of the *Scilla maritima*, a plant growing upon the shores of the Mediterranean Sea. It is a perennial plant, having a large, pyriform bulb, from which spring long, shining green leaves, and a single long flower-stem. There are two varieties, the *white* and the *red;* but they are similar in properties. The bulb is sometimes imported whole, but generally in transverse or longitudinal slices; of a yellowish-white colour; contorted; tough; of a feeble odour, and a bitter, nauseous taste. Imparts its virtues to alcohol, water, and vinegar. Contains a peculiar principle called *scillitin.*

Effects.—In moderate doses, stimulant to most of the secretions, particularly the kidneys and lungs. In large doses, it is emeto-cathartic. Much used in dropsies of an enfeebled character. Often advantageously combined with calomel, and sometimes with digitalis. Dose, 1 to 3 grs., two or three times a day, gradually increased till some obvious effect is produced. As a diuretic, it is usually given in form of pill or powder. The *preparations* of squill are noticed under the head of *Expectorants.*

MEADOW SAFFRON. (*Colchicum*, U. S.)— *Corm* and *seeds* of the *Colchicum autumnale;* a native of Europe; grows about 6 or 7 inches high. Corm about the size of a chestnut, covered with a brownish membrane; internally, solid, white, and fleshy. It should be gathered in July or August. Sometimes the bulb is dried whole, but generally it is cut into transverse slices about an eighth of an inch thick, whitish, inodorous, of a bitter and acrid taste. The pieces should each have a notch on one side. Apt to be spoiled in keeping; hence very uncertain, as found in the shops. The seeds are small, of a reddish-brown colour and of a bitter, acrid taste; the virtues reside

in the outer coating. The seeds contain all the virtues of the bulb, and are less apt to be injured by keeping. It contains a peculiar alkaline crystalline principle, called *colchicia,* not identical with veratria, as was at one time supposed. The virtues are best imparted to wine and vinegar.

Effects. — Stimulant to most of the secretions; rather reduces the action of the heart and arteries; seems also to influence the nervous system. In very large doses it is irritant to the stomach and bowels. It is chiefly used in gout and rheumatism, in which it may be combined with saline cathartics and antacids. *Scudamore's Mixture* consists of a draught containing 15 to 20 grs. magnesia, ℈j to ℈ij sulph. magnesia, and f℥j to f℥ij vinegar of colchicum. Dose of the corm or seeds, gr. j–iij,—rarely used.

Vinum Colchici Radicis, U. S. — Contains half a pound of the bruised corm in a pint of wine; colour, dark reddish-brown; dose, 30 drops up to f℥j, gradually increased.

Vinum Colchici Seminis, U. S.—Is made by macerating ℥ij bruised seeds in a pint of wine for 14 days; dose, the same.

Acetum Colchici, U. S. (*Vinegar of Colchicum*), — made by macerating the corm in vinegar, then adding alcohol. Dose, gtt. xx.--xxx.

Tinctura Colchici Seminis, U. S.—Dose, same as the above.

Extractum Colchici Aceticum, U. S.—A good preparation. Dose, gr. i–iij, three or four times a day.

The *White Hellebore of Europe* (*Veratrum album*), and the *Green Hellebore of the U. S.* (*Veratrum viride*), are analogous in their properties to colchicum. Both depend for their activity upon a powerful alkaline principle called *veratria.* Veratria is occasionally employed externally in the form of ointment, in cases of neuralgia. It is a violent acrid poison; even its external application is attended with a burning, tingling sensation.

The *ointment* is made by rubbing up 10 or 20 grs. with an ounce of lard. The dose of veratria is the twelfth to the sixth of a grain.

Turpentine. (*Terebinthina,* U. S.)—Juice of different species of the *Pinus, Abies,* and *Larix.* Many varieties of turpentine are known in commerce, but only two are used in the United States.

1. *White Turpentine* (*Terebinthina,* U. S.)—Derived chiefly from the *Pinus palustris,* or long-leaved pine of the South. Grows from 60 to 70 feet high; the leaves are in threes, about a foot in length. The turpentine is collected by making incisions in the trunk of the tree in spring, when the juice exudes, and is collected in barrels. It hardens on exposure. Colour, yellowish-white; odour, peculiar; taste, hot, bitter and pungent, depending on the volatile oil.

2. *Canada Turpentine* (*Terebinthina Canadensis,* U. S.)—Sometimes called *Balsam of Fir,* and *Canada Balsam;* product of the *Abies balsamea* or *Balm of Gilead;* found in vesicles under the bark.

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It is a transparent, yellow, thick liquid; odour, terebinthinate and aromatic; taste, same as the former.—All the turpentines are inflammable, scarcely soluble in water, soluble in alcohol; chemical composition, a resin and a volatile oil.

Uses.—In chronic rheumatism, chronic bronchitis, and chronic disorders of the urinary organs; also, externally, as stimulants to indolent ulcers. Dose, gr. x to ʒj. Sometimes given by enema.

The *oil of turpentine*, already alluded to under the head of Arterial Stimulants, is more frequently employed as a diuretic in chronic nephritic complaints; dose, 10 to 20 drops.

Tar (*Pix Liquida*, U. S.)—Procured chiefly from the *Pinus palustris* of North Carolina, by the slow combustion of the wood arranged in large piles. It is an empyreumatic product, consisting of a resin held in solution by acetic acid and empyreumatic oil, and coloured by charcoal: slightly soluble in water; more so in alcohol and ether. The aqueous solution—*tar water*—is used in chronic pectoral complaints. The *vapour* of tar is employed for the same affections, by inhalation. Dose, internally, ʒss to ʒj.

The *ointment* of tar is officinal;—used in tinea capitis.

Pitch is the residue after the volatile parts are driven off from tar;—used in plasters.

Creasote (*Creasotum*, U. S.)—Is one of the ingredients in the volatile oil of tar. Colourless when pure, of an oily aspect, very volatile; odour, strong, peculiar, and empyreumatic; taste, hot and acrid; slightly soluble in water; much more so in alcohol. *Uses.*—Antiseptic, styptic; employed in sickness of stomach and in hæmatemesis; dose, 1 drop every half hour, or hour. Used externally as a stimulant; also in the form of ointment.

Resin (*Resina*, U. S.)—The residue after the distillation of the oil of turpentine; two varieties—the *yellow* and *white*.

Uses.—Chiefly to form plasters.

Resin Cerate—Basilicon Ointment (*Ceratum Resinæ*, U. S.)—An excellent stimulant application to ulcers arising from burns.

Emplastrum Resinæ, U. S. (*Adhesive Plaster.*)

Copaiva. (*Copaiba*, U. S.)—Product of the *Copaifera officinalis*, a tree of South America. Procured by making *incisions* in the tree. As it flows first, it is clear, but becomes thick and dark by exposure; colour, orange-red; odour, peculiar and strong; taste, hot and bitter; insoluble in water, soluble in alcohol. Chemically, a volatile oil and an acid resin called *copaivic acid;* virtues depend on the oil, which may be separated by distillation. Copaiva will solidify, if exposed to the air in thin layers; also if rubbed up with magnesia.

Uses.—A stimulant diuretic, sometimes producing nausea and vomiting; acts also upon the mucous membranes generally. Employed chiefly in gonorrhœa, before or after the inflammatory symptoms; also in chronic dysentery, and chronic bronchitis.

Dose, 10 drops to ʒss, 3 times a day; of the volatile oil (*Oleum Copaibæ*, U. S.), 5 to 10 drops. Copaiva is often given in the form of *capsules*.

Pilulæ Copaibæ, U. S., are made by rubbing up copaiva with magnesia. Dose, gr. x–xx.

Cantharides. (*Cantharis*, U. S.)—History, &c., described under the head of *Epispastics*. As a diuretic it is more stimulating than the preceding, being apt to irritate the urinary organs, and produce strangury. Used chiefly in chronic disorders of the urino-genital organs, as chronic gonorrhœa and leucorrhœa, incontinence and retention of urine, spermatorrhœa, and amenorrhœa; also in obstinate skin diseases. Dose, gr. j, two or three times a day; generally given in the form of *tincture* (*Tinct. Cantharidis*, U. S.),—dose, 10 drops, gradually increased till some obvious effect is produced.

MILDER DIURETICS.

Juniper Berries. (*Juniperus*, U. S.)—Fruit of the *Juniperus communis*, an evergreen shrub, growing in both continents;—about the size of a pea, globular, of a dark-purple colour, glaucous and shrivelled. Imported chiefly from Trieste. Odour, aromatic; taste, sweetish, warm, and terebinthinate; virtues depend on a volatile oil, and are yielded to water and alcohol.

Effects.—A good, moderately stimulant diuretic and carminative; used chiefly as an adjuvant;—with cream of tartar, as a drink, in dropsy. The *infusion* contains ʒj of the bruised seeds to Oj of water. Dose of the *oil* (*Oleum Juniperi*, U. S.), 5 to 15 drops, several times a day.—*Spiritus Juniperi Compositus*, U. S., is an alcoholic solution of the oils of juniper, caraway, and fennel.—The tops are also occasionally used in medicine.

Indian Hemp. (*Apocynum Cannabinum*, U. S.)—Root of the *A. cannabinum*, an indigenous, herbaceous plant, emitting a milky juice when wounded. Odour, strong; taste, bitter and nauseous; virtues to water and alcohol. In full doses acts as an emeto-cathartic; occasionally a very powerful diuretic in some cases of dropsy. Dose of the decoction (ʒss in Oiij water, boiled down to Oj), f ʒj to f ʒij, three times a day.

Dandelion. (*Taraxacum*, U. S.)—Root of the *Leontodon taraxacum*, an herbaceous, perennial plant. The root is spindle-shaped, several inches long, of a brownish colour externally, lighter within; all parts abound in a milky, bitterish juice, particularly the root which is more powerful in the fresh state.

Effects.—Tonic, diuretic, and laxative; believed to have a specific influence over the liver; used in dyspepsia attended with derangement of the liver; and in certain forms of dropsy.

Infusion. (*Infusum Taraxaci*, U. S.) — ℥j of the fresh, or ℥ij of the dried root, in Oj water;—dose, f℥ij several times a day.

Extract. (*Extractum Taraxaci*, U. S.)—Prepared by bruising the fresh root, straining, and evaporating;—dose, 20 to 30 grs.

Fleabane. (*Erigeron*, U. S.)—Herbaceous plants of the *E. heterophyllum*, and *E. Philadelphicum*, indigenous plants. They are gently diuretic, and are chiefly employed as adjuvants in dropsy, and in chronic nephritic disorders. Best given in decoction (℥j to Oj water,)—the whole to be taken in the course of the day. An essential oil, obtained by distillation from this plant, has lately been extolled as a hemostatic, particularly in uterine hemorrhage.

Wild Carrot. (*Carota*, U. S.)—Seeds of the *Daucus carota*, an indigenous, perennial plant. The flowers are in umbels, which are flat at first, but afterwards contract so as to form a cup. The seeds are brownish, of an oval shape, with stiff hairs attached. Odour, slight; taste, aromatic and bitter; contain a volatile oil, which may be separated by distillation.

Effects.—A moderately stimulant diuretic; used as an adjuvant in dropsy, in the form of infusion.

The garden carrot has similar properties, though feebler. It is sometimes used, grated, as a poultice.

Parsley Root. (*Petroselinum.*) — Has also diuretic properties; the same is true of *Horseradish* and *Mustard.* Sometimes an infusion of several of these is given, in cases of dropsy of an enfeebled character.

Sweet Spirits of Nitre. (*Spiritus Ætheris Nitrici*, U. S.)—Prepared by the action of sulphuric acid on alcohol and nitrate of potassa, by distillation; chemically, the hyponitrite of ethyle, dissolved in alcohol.

Prop. — Colourless, limpid, of an ethereal odour, and a pungent, sweetish taste; apt to deteriorate when kept, becoming acid; soluble in alcohol and water; apt to be impure, as found in the shops. It is diaphoretic, diuretic, and antispasmodic; much used in fevers with nervous irritability, especially for children. Dose, 20 drops to f℥j every 2 or 3 hours.

The only *sedative* diuretic much employed is *Digitalis.* It does not succeed so well in dropsies attended with much plethora, as in those of a relaxed debilitated character. It is useful in cases accompanied with albuminous urine. Its diuretic powers are increased by combining it with squill and calomel. It is not very speedy in its operation, generally requiring several days to produce its diuretic effect. Dose of powder, one grain twice a day; of the tincture, 10 drops; of the infusion, f℥ss.

CLASS XIII.

DIAPHORETICS.

Diaphoretics are medicines which increase the function of perspiration; the name *sudorifics* is often also applied to them. They act in different ways: (1) by relaxing the surface; (2) by direct stimulation of the sudoriferous glands; (3) by stimulating the system generally; (4) by sympathy from the stomach; (5) by filling the blood-vessels. As a class of medicines, their action is not very certain, depending a good deal upon the state of the system at the time, and also upon the temperature and hygrometric condition of the atmosphere. They are useful as evacuants, promoting at the same time absorption; they also produce revulsion to the surface. Diaphoretics may be divided into the *refrigerant*, the *nauseating*, and the *alterative.*

REFRIGERANT DIAPHORETICS.

Citrate of Potassa. (*Potassæ Citras*, U. S.)—Prepared by action of citric acid, or lemon-juice, on carbonate or bicarbonate of potassa. A white, soluble, deliquescent salt; used as a diaphoretic in fevers, particularly in the forms of *neutral mixture* and *effervescing draught.*

Neutral Mixture. (*Solutio Potassæ Citratis*, U. S.)—Prepared by saturating lemon-juice (or an ounce of citric acid, rubbed up with four minims of oil of lemons, and dissolved in a pint of water), with carbonate, or preferably, the *bicarbonate* of potash, and filtering. Dose, a tablespoonful every hour or two: this quantity contains 15 grains of the salt.

The *effervescing draught* is the same, given in a state of effervescence. It is made by dissolving ʒij of the carbonate, or ʒiij of the bicarbonate in fʒiv water; then add a tablespoonful of this solution, mixed with the same quantity of water, to a tablespoonful of sweetened lemon-juice, or citric acid solution. Laudanum, in small quantities, may be added, if it produces griping.

Spirit of Mindererus. (*Liquor Ammoniæ Acetatis*, U. S.)—Prepared by the action of distilled vinegar on carbonate of ammonia. A limpid, colourless liquid, when properly made; taste, cooling and bitterish; an excellent diaphoretic in fevers. Dose, a tablespoonful every hour or two.

Nitrate of Potassa,—already spoken of as a refrigerant. It will frequently produce diaphoresis, especially if combined with other medicines of this sort; the *Nitrous Powders* are a combination of tartar emetic, nitre, and calomel. Nitre and tartar emetic are often prescribed, as a diaphoretic, in solution.

NAUSEATING DIAPHORETICS.

The Nauseating Diaphoretics comprise such medicines as produce diaphoresis, by relaxing the cutaneous capillaries; in this way, nearly all emetic substances will promote perspiration, if given in small doses. The only ones much employed are, Ipecacuanha and Tartar emetic. They are indicated in all cases of high arterial excitement, not attended with irritation or inflammation of the stomach.

Tartar emetic is usually given in the dose of the sixth to the twelfth of a grain. *Ipecacuanha* is chiefly used as a diaphoretic, in combination with opium, in the form of *Dover's Powder*—(*Pulvis Ipecac. et Opii*, U. S.)—This is made by rubbing up one part of ipecac. and opium each, with eight parts of sulphate of potassa; the dose is 10 grains. It is a very useful anodyne diaphoretic, in rheumatism, diarrhœa, and dysentery; also in pneumonia and bronchitis, after proper depletion; it should not be used, if there be much arterial excitement, or determination to the head.

ALTERATIVE DIAPHORETICS.

The chief Alterative Diaphoretics are Sassafras, Mezereon, Guiacum, and Sarsaparilla.

SASSAFRAS. U. S.—Bark of the root of the *Sassafras officinale*, an indigenous tree. Occurs in irregular fragments, of a reddish cinnamon-colour, brittle, of a very aromatic odour and taste. Virtues depend on a volatile oil. It is a mild stimulant diaphoretic, used chiefly in domestic practice; not much employed alone, but forms an agreeable adjuvant to other medicines. It is one of the ingredients in the *Compound Decoction of Sarsaparilla.*

The *sassafras pith* (*Sassafras Medulla*, U. S.) is procured from the young twigs. It is in cylindrical pieces, white, and very light; forms with water a thick, gummy solution. The mucilage is made by adding ʒj to Oj of boiling water; it is a very pleasant application to irritated or inflamed surfaces, as in ophthalmia, erysipelas, eczema, &c.

MEZEREON. (*Mezereum*, U. S.)—Product of several species of the *Daphne*, especially the *D. mezereum*, a shrub three or four feet high, growing in Europe. The bark of the root is the part directed by the Pharmacopœias, but the bark derived from the branches is generally found in the shops. It comes in strips three or four feet long, folded in bundles, or wrapped in balls; covered externally with a grayish-brown epidermis, whitish within, tough and pliable. Taste, sweetish at first, then very acrid; it yields its properties to boiling water. It contains a peculiar principle called *daphnin*, which, however, is not active: its activity depends on an acrid resin. The fresh bark applied to the skin will produce vesication. An *ointment* (*Unguentum Mezerei*, U. S.), made from the bark, is used to maintain the discharge from blisters.

Mezereon is a stimulant alterative diaphoretic, if directed to the skin; it will act also on the kidneys. Used chiefly in combination with others, in chronic skin diseases, chronic rheumatism, and secondary syphilis. Best given in the form of *decoction*, made by boiling ℨij mezereon, and ℨss liquorice root, in Oiij water, down to Oij. Used sometimes as a *masticatory* in cases of paralysis of the tongue.

Guaiacum Wood, and Guaiac. (*Guaiaci Lignum et Guaiaci Resina*, U. S.)—Products of the *Guaiacum officinale* (Fig. 365), an

Fig. 365.

evergreen tree of South America and the West Indies. The wood comes in billets, covered with a grayish bark, extremely hard and compact; the alburnum, or sap wood, is of a yellowish colour; the heart wood of a brownish green; commonly called *lignum vitæ.* It has no odour except when rubbed or burned; taste, bitterish and pungent; activity depends on the contained guaiac.

Guaiac (*resin*) is procured either by spontaneous exudation, or by boiling the raspings and shavings in water, or by heating in the fire billets of the wood which have been bored longitudinally. It comes in masses of a deep olive-brown colour, mixed with various impurities; fracture resinous; odour feeble and balsamic; taste slight at first, but afterwards acrid; melts by heat, evolving a fragrant odour. Chemically, a mixture of a peculiar extractive, called *guaiacin,* and a resin; much more soluble in alcohol than in water.

Effects.—Stimulant, alterative, and diaphoretic; in large doses irritant to the bowels. Used in chronic rheumatism, secondary syphilis, and chronic skin diseases. Dose of guaiac, 10 to 30 grains. There are two tinctures, the *simple* and the *volatile* or *ammoniated;* the latter is used in dysmenorrhœa;—dose of either, fʒj.

Sarsaparilla, U. S.—Root of different species of the genus *Smilax*, as the *S. officinalis*, *S. medica*, *S. papyracea*, &c.;

perennial, climbing plants, growing in Mexico and South America. The leaves are ovate, and alternately inserted upon short footstalks, with numerous tendrils proceeding from the stem. The roots are very long and slender, inserted upon a common caudex. Several varieties are known: — 1. *Honduras sarsaparilla,* — comes in bundles two or three feet long, consisting of one or more roots, folded lengthwise, and secured by a few circular turns. 2. *Jamaica sarsaparilla,*—distinguished by the reddish colour of its epidermis, probably of similar origin with the last. 3. *Brazilian,* or *Para sarsaparilla,* sometimes called *Lisbon* and *Rio Negro* sarsaparilla, — this comes in cylindrical bundles, about three feet long and one thick; it is an excellent variety. There are also the *Caraccas* and *Mexican* varieties.

The dried root has but little odour; a mucilaginous and acrid taste, especially when chewed for some time; imparts its virtues to water and alcohol; the cortical portion is the most active. It contains a peculiar principle, called *sarsaparillin* or *smilacin,* also much starch, lignin, &c. Long boiling is injurious to it.

Effects. — An alterative diaphoretic; sometimes creates nausea and vomiting. Improves the state of the constitution; slightly strengthens and induces plumpness and cachectic cases, and in depraved states of the general health. Useful in secondary syphilis, chronic rheumatism, chronic cutaneous diseases, &c. It is not often administered alone; generally in combination with the other stimulating diaphoretics. Dose of powder, ʒss to ʒj; of the *Infusion* (*Infusum Sarsaparillæ,* U. S.), made by macerating ℥j of the root in a pint of boiling water, f℥iv. The *Compound Decoction* (*Decoctum Sarsaparillæ Compositum,* U. S.), is made by boiling together bruised sarsaparilla with guaiacum wood, mezereon, liquorice root, and sassafras, in water, for fifteen minutes, and then straining. It is made in imitation of the *Lisbon diet drink.* Dose, f℥iv several times a day. The *Compound Syrup* (*Syrupus Sarsaparillæ Compositus,* U. S.) is also officinal, — an excellent preparation; it contains sarsaparilla, guiacum wood, red roses, liquorice root, the oils of sassafras, anise, and partridge-berry. Dose f℥ss, three times a day.

The *Fluid Extract* (*Extractum Sarsaparillæ Fluidum,* U. S.) is made by macerating bruised sarsaparilla, liquorice root, sassafras bark, and mezereon, in dilute alcohol for fourteen days, then filter, add sugar, and evaporate down to the requisite bulk. It is a strong and certain preparation; dose, fʒi–ij.

The root of *Aralia nudicaulis,* or *False Sarsaparilla,* an indigenous plant, possesses kindred properties to those of sarsaparilla. *Uses,* the same.

CLASS XIV.

EXPECTORANTS.

MEDICINES which increase or promote the evacuation of the bronchial secretions. In the healthy condition there is a certain amount of secretion always going on in the air passages, which is removed by evaporation or absorption; but in disease of these organs, there is either an arrest of the natural secretion, or it becomes excessive, and *cough* results.

Some expectorants are thought to act by producing relaxation, as the nauseating expectorants; others by stimulating the mucous exhalants; some, possibly, by sympathy from the stomach. The nauseating class are alone indicated in cases of inflammatory or febrile excitement; the stimulating, in cases of enfeebled action, or when of long duration. *Anodynes* are useful adjuvants, when the expectoration is attended with pain.

NAUSEATING EXPECTORANTS.

The *emetics*, generally, prove expectorant, in consequence of the relaxation produced; only two, however, are much employed with this view, *tartar emetic* and *ipecacuanha;* the dose of the former is ⅛ grain, or of *antimonial wine,* 15 to 25 drops every two hours; the dose of the ipecacuanha is gr. ss–j, or of the wine, 25 to 30 drops.

Fig. 366.

STIMULANT EXPECTORANTS.

SENEKA. (*Senega,* U. S.)—Root of the *Polygala senega,* indigenous in the United States. A small, herbaceous perennial, with alternate smooth leaves. The root consists of a thick, knotty head, with the radicles much twisted, with a projecting, keel-like line. Colour, yellowish brown externally, whitish within, the cortical portion contains the active principle, named *senegin* or *polygalic acid.* Odour, peculiar; taste, at first sweetish and mucilaginous, then acrid. Water and diluted alcohol extract its virtues.

Effects.—A stimulant expectorant, and diuretic; large doses act as an emeto-cathartic; sometimes also produce diaphoresis and emmenagogue effects. Used as an expectorant, where there is no inflammation; in latter stages of bronchitis, humoral asthma, secondary croup, &c. An ingredient in *Coxe's Hive Syrup.* Dose, 10 to 20 grains —of the decoction, (*Decoctum Senegæ*, U. S.; ℥j to Oiss water down to Oj) f℥j to f℥ij, three times a day;—of the syrup (*Syrupus Senegæ*, U. S.), f℥j.

Squill. — Already described as a *diuretic.* As an expectorant, it much resembles senega, and is used in similar cases. May be advantageously combined with ipecacuanha, or tartar emetic. Dose, gr. j, several times a day; of the *vinegar*, fℨss to fℨj; — of the *syrup*, or *oxymel*, the same dose; — of the *tincture*, 20 to 40 drops. *Coxe's Hive Syrup* (*Syrupus Scillæ Compositus*, U. S.), contains equal parts of squill and senega, together with tartar emetic; much used in croup, catarrh, and hooping-cough; dose for a child, 10 drops to fℨj, according to the age.

Black Snake-Root. (*Cimicifuga*, U. S.) — Root of the *Cimicifuga racemosa*, sometimes called *cohosh* and *richweed*, an indigenous perennial plant, several feet high, having ternate leaves, and long racemes of white flowers. The root consists of a tuberculated caudex, several inches long, from which numerous slender, brittle radicles proceed. Colour, blackish; odour, feeble; taste, bitter, earthy, and astringent. Virtues to boiling water; strongest when fresh.

Effects. — Not especially an expectorant, but a general tonic and stimulant to the secretions, especially of the lungs, skin, and kidneys. In very large doses, it seems to affect the brain. Used in rheumatism, hysteria, and pulmonary disorders; also an excellent remedy in chorea. Dose of *decoction*, (℥j to Oj water), a teacupful, several times a day.

Garlic. (*Allium*, U. S.) — Bulb of the common garlic, *Allium sativum.* It is about an inch in diameter, flattened, is covered by a membrane, and consists of several small conical bulbs, arranged round a common stem, called *cloves.* Odour, strong; taste, acrid and bitter, depending on a volatile oil, which is of a yellow colour, extremely acrid and irritating. The expressed juice is the best for internal use; to be given mixed with sugar. Dose, fℨss to fℨj. A *syrup* also given. *Used* in chronic catarrhs, asthma, &c. Sometimes employed externally, as a poultice to the feet of children.

Assafetida. — As an expectorant, a good deal resembles *garlic.* A valuable remedy in coughs of a nervous character, as hooping-cough, spasmodic asthma, infantile coughs, and coughs of old people. Dose, 5 to 15 grains, given in pill or emulsion.

Ammoniac. (*Ammoniacum*, U. S.) — Inspissated juice of the

Dorema ammoniacum, an umbelliferous plant of Persia. Found in *tears* and in *masses;* the former is the purest; occurs in pieces of various size, spheroidal; of a reddish-yellow colour externally; brittle when cold; of a resinous fracture. The masses are of a darker colour, and contain many impurities. Odour, peculiar, increased by heating it; heat softens, but does not melt it; taste, bitter, nauseous, and acrid; chemically, a gum-resin and volatile oil, partially soluble in water and entirely in alcohol; forming, with the former, a milky emulsion, and with the latter, a clear tincture.

Effects.—Similar to those of assafœtida, and the other fetid gum-resins. Used chiefly as a stimulant expectorant, in chronic enfeebled cases. Dose, 10 to 30 grains.

Pilulæ Scillæ Compositæ, U. S.—Contain squill, ammoniac, ginger, and soap;—dose, 5 to 10 grains, several times a day.

Externally applied, ammoniac causes irritation of the skin. Used sometimes as a *plaster* (*Emplastrum Ammoniaci*, U. S.).

GALBANUM, U. S.—A substance much resembling ammoniac in its medical properties; little used except for making plasters.

BENZOIN. (*Benzoinum*, U. S.)—The product of *Styrax Benzoin*, a native of Siam and Malacca. The juice which exudes on incision, hardens on exposure. It is a balsam, used for obtaining *benzoic acid*.

BALSAM OF TOLU. (*Balsamum Tolutanum*, U. S.)—Product of the *Myrospermum Toluiferum*, or *Myroxylon Toluiferum*, growing in South America.—Procured by making incisions into the tree. When first procured, it is of a soft, tenacious consistence, but becomes hard and darker by exposure; odour, very fragrant; taste, pleasant and sweetish; inflames by heat; soluble in alcohol, ether, and the fixed oils; boiling water extracts its benzoic acid; chemically, it consists of benzoic acid, volatile oil, and cinnamic acid. The acid may be separated by sublimation;—it is used in making the *paregoric elixir*.

Effects.—A stimulant expectorant; used in chronic pulmonary complaints; a pleasant adjuvant to cough mixtures; dose, 10 to 30 grs. The *tincture* (*Tinc. Tolutana*), and *syrup* (*Syrupus Tolutanus*), are officinal; the latter used to flavour cough mixtures.

BALSAM OF PERU. (*Balsamum Peruvianum*, U. S.)—Product of the *Myroxylon Peruiferum*, or *Myrospermum Peruiferum*, growing in South America.—Believed to be procured by boiling the young branches; supposed by some, that both the balsams are the product of the same tree, one being obtained by exudation, the other by decoction. A thick, viscid fluid, resembling molasses; colour, dark reddish-brown; odour, fragrant, less pleasant than that of Tolu; taste, warm, bitter, and pungent; inflammable; yields its benzoic acid to boiling water; chemical composition, the same as that of Tolu.

Effects.—A warm stimulating expectorant and tonic, adapted to the same cases as the preceding; used sometimes externally to indolent ulcers. Dose, f℥ss.

CLASS XV.

EMMENAGOGUES.

MEDICINES which promote the menstrual discharge. It is questionable whether there are any medicines which *specifically* affect the uterus; most of them seeming to act by contiguous sympathy. As amenorrhœa is sometimes a primary disease, and sometimes the result of other causes, the treatment must, in the first place, be directed to the restoration of the constitution to a natural state; in plethoric cases, depletion will be required; in the relaxed, a tonic course; in chlorosis, the chalybeates. Emmenagogues are usually most efficient when given just before the expected period of the discharge.

SAVIN. (*Sabina*, U. S.)—Leaves of the *Juniperus sabina*, an evergreen shrub, indigenous in Europe, and cultivated in the United States. It resembles in appearance the red cedar. As found in the shops, the leaves are of a greenish colour, strong, heavy odour, and bitter and acrid taste; active properties depend on a yellow volatile oil.

Effects.—A stimulant to the secretions generally; over-doses are very irritant, and even poisonous; by some highly esteemed as an emmenagogue; its use very dangerous in pregnancy, in consequence of the irritation or inflammation of the uterus produced, bringing on abortion. It is questionable whether it has the power of directly exciting uterine contraction. Dose, 5 to 20 grs.; of the oil, 2 to 5 drops, three times a day;—acts as a rubefacient, when applied to the skin.

Most of the drastic cathartics will prove emmenagogues, probably through the sympathy existing between the bowels and uterus. The two most employed are *aloes* and *black hellebore*.

ALOES is one of the most efficient remedies in amenorrhœa, particularly when combined with iron and assafœtida. It is contra-indicated in cases of inflammation or hemorrhoids. Dose, 1 or 2 grs., two or three times a day.

BLACK HELLEBORE—an uncertain emmenagogue, as found in the shops; usually given in the form of tincture; dose, f℥ss to f℥j, two or three times a day.

GUAIAC is by many highly recommended in amenorrhœa. Dr. Dewees praises it also in dysmenorrhœa. Best given either in the form of *tincture*, or *ammoniated tincture*; dose, f℥j, three times a day.

SENEKA is also esteemed emmenagogue by some writers; it is a general stimulant to the secretions, and may sometimes promote menstruation.

Cantharides will often produce a decided emmenagogue effect; indicated only in cases of enfeebled action; never in cases of inflammation. Dose of tincture, 10 to 30 drops, three times a day. A blister to the sacrum will sometimes have the same effect.

The *Preparations of* Iron are perhaps the most certain of all the emmenagogues; they are more employed than the others; the *sub-carbonate*, or the *sulphate*, usually preferred. They are particularly indicated in cases of chlorosis; never in plethora; often combined with aloes.

CLASS XVI.

SIALOGOGUES.

Medicines which promote the secretion of the saliva. Some articles effect this when taken internally, as antimony, silver, nitro-muriatic acid, iodine, and especially mercury; others produce it by a topical or local action, as mustard, ginger, tobacco, &c. As remedies, they are employed in paralytic affections of the tongue and throat; in diseases of the tonsils or salivary glands; sometimes as revulsives from neighbouring organs, as in toothache and earache. They are also called *masticatories*. They are all described under other heads.

CLASS XVII.

ERRHINES.

Substances which promote the nasal secretion. As they generally excite sneezing, they are also termed *sternutatories*. They all act by direct application; and nearly any foreign substance applied to the mucous membrane of the nose will produce this effect. They are used as revulsives in amaurosis, chronic ophthalmia, &c.; also in syncope; also to promote the discharge of accumulated mucus, and of foreign bodies. The most powerful errhines, are Tobacco, Ammonia, Euphorbium, and Veratria.

CLASS XVIII.

EPISPASTICS.

Medicines which, when applied to the skin, produce a blister. Called also *vesicatories*. The Rubefacients will also blister if applied for a sufficient length of time.

Effects. — They act as general stimulants to the system; and are useful in typhoid cases; they will sometimes set aside a paroxysm of intermittent or remittent fever, by virtue of the powerful impression produced. They are powerfully revulsive, and are used in diseases of the internal organs. It is advisable not to employ them in the very height of inflammatory diseases, lest the excitement should be increased. They produce local depletion by the serous discharge which they occasion. They also do good in certain cases, by substituting their own action, which spontaneously subsides, for some morbid action in the part, as in obstinate herpes, &c. They are also employed for their local stimulant action; for the pain, which they cause, in hypochondriasis; and to procure a denuded surface for the endermic application of medicines.

Spanish Flies. (*Cantharis*, U. S.) — The *Cantharis vesicatoria* is an insect from six to ten lines in length, by two or three in breadth, of a shining green colour. They abound in the south of Europe, and are collected in the summer by shaking them from the trees in which they lodge, and letting them fall into large cloths, which are plunged into hot vinegar and water, for the purpose of destroying the insects: they are then perfectly dried in the sun, and put into canisters. Odour, strong and peculiar; taste, acrid and burning; colour of powder, grayish-brown, with fragments of shining green. Should not be kept in the powdered state, as it is very apt to attract moisture and decompose. Apt to be attacked by insects; virtues to water and alcohol. Contain a peculiar crystalline principle called *cantharidin*.

Effects. — Internally, a diuretic and emmenagogue; externally, it forms the best epispastic. The following are its preparations:

Ceratum Cantharidis, U. S.—(*Blistering Plaster.*)—Made by mixing together yellow wax, resin, lard, and powdered flies. This is the preparation used for spreading blisters. Soft leather, muslin, adhesive plaster, or paper may be employed, and the cerate applied with a spatula, without heat. The shape and size of the blister must be determined by the part to which it is to be applied. Sometimes a thin gauze is interposed between the skin and cerate, which is thought to prevent the absorption of the active principle. From six to eight hours is sufficiently long to allow a blister to remain on: if vesication has not then taken place, a warm poultice is to be applied. For children, a much

shorter time will suffice. The best *dressing* is simple cerate; or, if to be kept discharging, basilicon ointment; if not disposed to heal, a mixture of Goulard's and simple cerate. The strangury, often resulting from the application of blisters, is best relieved by an anodyne enema, and the free use of diluent drinks.

Unguentum Cantharidis, (U. S.)—Used only for dressing blisters, to maintain the discharge. Prepared by mixing the decoction witl resin cerate, and evaporating to a proper consistence.

Emplastrum Picis cum Cantharide, (U. S.)—*Emplastrum calefa ciens,* or *warming-plaster.* Prepared by melting together the cerate of cantharides with Burgundy pitch. Used as a gentle rubefacient in chronic cases. It sometimes causes vesication, particularly if improperly made.

Linimentum Cantharidis, (U. S.)—Made by digesting cantharides in oil of turpentine. A very powerful, prompt, and stimulating liniment and vesicant. Used sometimes in typhus fever.

Other species of the Cantharis possess vesicant properties, particularly the *C. vittata,* or *potato-fly,* which is indigenous. It is smaller than the preceding, but resembles it in all its medininal properties.

CLASS XIX.

RUBEFACIENTS.

Medicines which cause inflammation of the skin, when applied ex ternally. The indications for their use, as well as the principles of their operation, are very much the same as those of Epispastics. The latter are preferred when a slow and stimulant effect is desired; the former, where the impression is to be sudden and transient. Rubefacients cannot deplete like blisters; they are likewise inferior in their power of breaking up morbid associations, as in intermittents. As revulsives, rubefacients are most useful in spasm and nervous irritation; blisters, in local inflammations.

Burgundy Pitch. (*Pix Burgundica,* U. S.)—*Abies excelsa* or *Norway spruce fir,* a lofty evergreen, native of northern Europe. Procured by stripping off the bark, under which it concretes in large masses; then melting in boiling water, and straining. A spurious pitch is manufactured out of rosin and common pitch.—It is hard, brittle, and of a yellowish-brown colour, of a weak terebinthinate odour and taste; usually contains many impurities.—Used in the form of *plaster* to the skin, where it produces a mild rubefacient effect. In some persons it brings out a pustular eruption.

The *pitch plaster*, made by spreading the melted pitch on soft leather, is used in chronic pulmonary and rheumatic complaints, &c.

Canada Pitch. (*Pix Canadensis*, U. S.)—Product of the *Abies Canadensis* or *Hemlock spruce*, a native of Canada and the Northern States. The pitch, sometimes called *hemlock gum*, is a spontaneous exudation on the old trees; it is scraped off, boiled in water, and strained. It is hard and brittle, of a dark brownish colour, and feeble odour; heat softens and renders it adhesive.—Uses, and mode of application, the same as the former.

Solution of Ammonia. (*Liquor Ammoniæ*, U. S.)—Prepared by saturating water with gaseous ammonia; found in the shops of different strengths. Applied to the skin, it produces a rubefacient, or even epispastic effect very speedily; usually employed in combination with olive oil, in the form of *Linimentum Ammoniæ*, U. S., or *volatile liniment*,—made in the proportion of half an ounce of aq. ammoniæ to two ounces of oil; an excellent mild rubefacient in rheumatism, and catarrh, especially of children; may be farther diluted if too powerful.

Mustard. (*Sinapis*, U. S,)—Product of two different species, viz.: *Sinapis alba* and *Sinapis nigra* (Figs. 367, 368), natives of Europe. Two kinds of seeds are found, the *white* and the *black;* the former are of a light-yellowish colour, and globular; the latter are smaller, of a dark-brown colour, externally, and whitish within. They have no odour when whole; yield a yellow powder, which is decidedly odorous when moistened; taste, hot, pungent, and bitter; strongest in the black; the outer coating of both is mucilaginous; both yield a mild fixed oil, on pressure. The active principle of the black mustard is a volatile oil, which does not preexist in the seed, but is developed by the reaction of water upon two organic principles, named *sinapisin* and *myrosyne.* In the white mustard, the active principle is a fixed acrid substance, which does not pre-exist in

Fig. 368.

Fig. 367.

the seed, but is generated by the reaction of water on *sulpho-sinapisin* and *myrosyne*.

Swallowed whole, the seeds are stomachic and laxative, and are used in dyspepsia. The powder, in small doses, is stimulant; in large quantities, emetic. Externally applied, it is an active rubefacient, and is much used under the form of mustard poultice, or *sinapism*,—made by simply stirring up the powder with tepid water; flour may be added to dilute it. It should not be allowed to remain on longer than from 15 to 30 minutes; never to produce vesication. Care should be taken not to leave it too long on persons insensible to pain, lest ulceration and sloughing result.

Oil of Turpentine is a powerful rubefacient; used by saturating a flannel and applying it to the skin; sometimes produces a violent inflammation and eruption on the skin.

Cayenne Pepper may be advantageously used as a rubefacient, by heating it in spirits, and rubbing it over the surface; particularly applicable in the low forms of disease.

CLASS XX.

ESCHAROTICS, OR CAUSTICS.

Substances which cause a slough by destroying the life of the part to which they are applied. Some of them act directly, others indirectly, through chemical agencies. Used to form issues or running sores, to repress fungous granulations, to change the character of diseased surfaces, and to open abscesses.

The *hot iron*, or *actual cautery*, is the most powerful escharotic; not so much employed at present as formerly; occasionally used to arrest hemorrhage.

The *moxa* is a modification of the actual cautery; it consists of small rolls of muslin soaked in a solution of chromate, or nitrate of potassa, and dried. When used, one end is set on fire, and the other placed on the skin. It acts as a powerful revulsive;—useful in deep-seated pains, paralysis, disease of spine, &c.

Lunar Caustic. (*Argenti Nitras Fusus*, U. S.)—Made by dissolving pure silver in diluted nitric acid, evaporating, melting, and running into moulds. It occurs in cylindrical pieces, enveloped in paper to protect it from the light, which decomposes it. Colour, gray-

ish-white; taste, austere and metallic; very soluble. As a caustic, it acts through its chemical affinities for the albumen of the tissue. It is a safe and excellent escharotic; particularly useful to change the character of unhealthy ulcers, whether common or specific; the best application for ulcers of the cornea; also to inflamed tonsils. Sometimes a concentrated solution is preferred. The weak solution is an admirable stimulant application, as already noticed under the head of *Tonics.*

Potassa, U. S. (*Common caustic, Lapis infernalis.*)—Chemically a *hydrate of potassa;* made by adding quicklime to a solution of carbonate of potassa, and evaporating the resulting solution to a proper consistence, and then pouring into proper moulds. Occurs in cylinders of a gray colour; very deliquescent; powerfully alkaline; very soluble. A more powerful caustic than nitrate of silver; apt to extend its effects, and consequently not so safe; used chiefly to form issues, which is best effected by rubbing a moistened stick of potassa over a piece of sticking plaster, applied to the skin, and having a hole in it of the size of the intended issue; sometimes used also to open abscesses, and to destroy poisoned surfaces. The strong *solution* sometimes applied to the spine, in tetanus.

The *Potassa cum Calce*, U. S. (*Vienna paste*)—is used sometimes to open bubos.

Dried Alum. (*Alumen Exsiccatum*, U. S.)—Commonly named *burnt alum;* prepared by heating alum until deprived of its water of crystallization; a dull-whitish powder; a mild escharotic;—used to repress fungous granulations.

Sulphate of Copper.—Usually applied in the solid form; in which state it forms the best remedy in *granulated conjunctivitis.* A strong solution is useful in *cancrum oris;* the weaker solution is a good stimulant, as mentioned under the head of *Tonics.*

Arsenic. (*Acidum Arseniosum*, U. S.)—Procured in smelting the ores of arsenic; of a milk-white colour; vitreous fracture; transparent within, but becomes opaque on exposure; has no odour; taste, faintly sweetish; powerfully poisonous; soluble in water and alcohol. A dangerous escharotic from liability to absorption.—Used chiefly in cancerous sores; also in lupus, and onychia maligna; should always be very much diluted before applying it.

Corrosive Sublimate.—A powerful escharotic in the undiluted state, but seldom thus employed. A weak solution used as a gargle in venereal sore throat, and as a lotion in chronic skin diseases; recommended in onychia maligna, mixed with equal parts of sulph. zinc. More fully described under the head of *Mercury.*

The *solution of the nitrate*, and the *acid nitrate of mercury*, are also used as escharotics; the latter especially in ulcers of the uterus.

The *Mineral acids* are all powerfully caustic in the undiluted form; not used as such, however; but employed, sufficiently diluted, as stimulant washes to indolent ulcers.

CLASS XXI.

EMOLLIENTS.

MEDICINES which soften and relax the skin, when externally applied. They diminish the pain and tension of inflamed parts, often assisting in producing resolution; or, if too far advanced for that, they aid the suppurative process. Their action is believed to be purely mechanical. They all owe their efficacy to moisture; in fact, *water* is, by some, considered the only emollient; a temperature above 62° F. is requisite;—aqueous vapour is still more emollient than warm water. The usual method of applying emollients is by *cataplasm*, of which the best is that made from flaxseed meal. Nearly all the *Demulcents* have an emollient effect when externally applied.

CLASS XXII.

DEMULCENTS.

SUBSTANCES of a bland, unirritating nature, capable of forming a viscid solution with water. They are closely allied to Emollients; in fact, they produce the same effect upon the internal passages as the latter do upon the skin. They consist chiefly of gum, sugar, oil, or starch, and are useful both as adjuvants to other acrid or irritating medicines, and also, when given alone, to defend inflamed or irritated surfaces, with which they come into direct contact, as the stomach and bowels,—when they may be given either by the mouth, or by enema. Also very much used in inflammations and irritations of parts on which their action must be indirect, as in bronchitis and urinary disorders; in the latter instances, they probably act by being absorbed. Several of the demulcents are much used as articles of diet for the sick. They are also used, in solution, as vehicles for other medicines.

Gum Arabic. (*Acacia*, U. S.) — Product of several species of *Acacia*, especially the *A. vera*, *A. Senegal*, and *A. Arabica*. They are thorny shrubs, or trees, growing in the deserts of Arabia, Africa, and India. The gum exudes spontaneously and by incisions. The varieties are as follows: 1. *Turkey gum*, imported from the Levant; comes in small, irregular fragments, either whitish, or very light yellowish-red: among these are larger round pieces with numerous cracks, brittle, and completely soluble in water. 2. *Gum Senegal*, from the western coast of Africa; larger fragments, darker colour, less brittle, of a conchoidal fracture. 3. *Gum Barbary*, from the northern part of Africa; has a dark colour, apt to contain impurities, less abundant than the others.—Guerin has discovered three distinct principles in gum: — 1. *Arabin* — found in pure gum Arabic, and which is completely soluble in water. 2. *Bassorin* — found in Bassora gum; characterized by swelling up considerably in water, but not dissolving. 3. *Cerasin* — found in the gum of fruit trees; distinguished by being converted into arabin by the action of boiling water.

Fig. 369.

Uses.—Chiefly as a demulcent, in pectoral affections, diarrhœa, and dysentery; an ingredient in most cough mixtures; also in pharmacy, in the compounding of pills. *Mucilage* for drink is made by dissolving ʒj in Oj of water.

The *syrup* (*Syrupus Acaciæ*, U. S.), is chiefly used in pharmacy.

Tragacanth. (*Tragacantha*, U. S.) — Product of several species of *Astragalus*, particularly of *A. verus*, — small, thorny shrubs growing in Persia and Asia Minor. The gum exudes spontaneously. Occurs in irregular, tortuous pieces, of a dirty yellowish colour; translucent, resembling horn; hard, but difficult to pulverize; consists chiefly of *bassorin;* swells up, but does not dissolve in water,—forms with it a paste. A demulcent, — used chiefly in the preparation of troches.

Slippery Elm Bark. (*Ulmus*, U. S.)—Inner bark of the *Ulmus fulva*, a large indigenous tree. It is stripped off in pieces several feet in length, and folded longitudinally. Colour, tawny; texture, fibrous; odour, peculiar; taste, sweetish, peculiar, and mucilaginous. It is a good demulcent, and is used in dysentery, &c.; also nutritious; generally given in infusion. (*Infusum Ulmi*, U. S.) The powder may be employed by simply stirring in boiling water, and made of any thickness, and flavoured according to the taste. A poultice made

from the powder forms an excellent emollient application to the inflamed skin.

Flaxseed. (*Linum*, U. S.)—Seeds of the *Linum usitatissimum*, or common flax. They are about a line in length, oval, of a brown colour and glossy. The cuticle abounds in mucilage; the interior contains a fixed oil, which is procured by expression, and called *Linseed oil*—much used in the arts. The mucilage is obtained by infusing the seeds in boiling water; not proper to boil them, since the oil would then be extracted, which is unpleasant to the taste;—proportions, ℥j to Oj of water, flavoured with lemon-juice and sugar;—much used in pectoral and bowel affections, and nephritic disorders. The ground seed forms with hot water an excellent emollient poultice.

Irish Moss. (*Chondrus*, U. S.)—Usually called *Carrageen;*—botanically *Chondrus crispus*. It grows on the rocks on the northern coasts of Europe,—particularly Ireland; also in this continent. Consists of a flat, cartilaginous frond, several inches long, curled, and of a yellowish colour;—odour, feeble; taste, slight; insoluble in cold water, but soluble in boiling water;—contains starch, pectin, and other matters. A nutritive demulcent, used in pectoral complaints, dysentery, nephritic disorders, &c. Decoction, made by boiling ʒss in Ojss to Oj. Made also in the form of a jelly, properly flavoured, as an article of diet.

Iceland Moss. (*Cetraria*, U. S.)—Botanically, *Cetraria Islandica* (*Lichen Islandicus*); grows in the northern parts of both continents,—inland. It is from 2 to 4 inches long; dry, coriaceous, and smooth; deeply channeled; of a grayish-white and brown colour; no odour; of a bitter, mucilaginous taste; soluble in boiling water. It contains a bitter principle, *Cetrarin*, which renders it slightly tonic as well as demulcent;—the bitterness may be removed by weak alkaline solutions. Used in chronic pectoral affections, attended with debility; also in chronic diarrhœa and dysentery. Decoction made by boiling ʒj in Ojss of water down to Oj.

Liquorice Root. (*Glycyrrhiza*, U. S.)—Root of the *G. glabra*, growing in the south of Europe, having a round, tough and pliable root. As found in the shops, it is in long pieces, varying from a few lines to an inch in thickness; of a yellowish-gray colour externally; yellow within; taste, sweet and somewhat acrid. It contains a peculiar saccharine principle called *glycyrrhizin*, which differs from sugar in not undergoing the vinous fermentation; it also contains some starch, and a resinous acrid matter. A good demulcent,—used chiefly as an adjuvant with other acrid medicines. Decoction, made with ʒj to Oj water. The powdered root used for sprinkling over pills.

Liquorice (*Extractum Glycyrrhizæ*, U. S.),—made by evaporating the decoction. The best is imported from Calabria. Comes in black, flattened cylinders, about an inch in diameter, shiny when broken; of a sweet taste;—much used in cough-mixtures and lozenges.

Barley. (*Hordeum*, U. S.)—Prepared for medicinal use by cleaning the grain, and rounding and polishing in a mill; it then constitutes *pearl barley*. It is in small, white, oval grains, with a dark, longitudinal furrow on one side. Consists of starch, gum, sugar, and gluten;—apt to become musty by long keeping. Virtues yielded to boiling water.

Barley Water. (*Decoctum Hordei*, U. S.)—Made by washing ℥ij barley in cold water; then boil for ten minutes in a small quantity of water; throw away this water, and add Oij boiling water, and boil down to Oj;—an excellent drink in inflammatory and febrile affections; may be flavoured with lemon-juice and sugar.

Arrow Root. (*Maranta*, U. S.)—Product of the *Maranta arundinacea*, growing in the West Indies and Central America; also in Florida. The root is perennial and tuberous, and is prepared for use by first washing, then beating into a pulp, and thrown into water, and stirred, so as to separate the fecula; it is then strained through a sieve and allowed to dry. The best is imported from Bermuda. It is a white, light powder; no odour nor taste; chemically, a pure starch; often adulterated with potato starch; can only be distinguished by the microscope. A nutritious demulcent, particularly adapted to children as an article of diet, also in bowel-affections. Given, by first forming a paste with cold water, and then adding this to boiling milk or water.

The *Canna root*, or *Tous-les-mois*, is very similar to the arrow root: it comes also from the West Indies.

Tapioca, U. S.—Fecula prepared from the root of the *Jatropha manihot*, or *cassava plant*, a native of the West Indies and tropical America. The root is large, fleshy, and tuberous. There are two varieties, the sweet and the bitter. The latter contains an acrid, poisonous principle; still, it is the one most cultivated for tapioca, since its poisonous principle, being volatile, is dissipated by heat. The juice being expressed from the root, deposits its starch on standing, and is then dried by exposing it to heat. It is in irregular, hard, white, rough grains, with little or no odour and taste. Prepared for use by boiling in water, which converts it into a sort of jelly. Used exclusively as an article of diet; may be flavoured to suit the taste;—brandy or wine may be added, in cases of debility, or irritability of stomach.

Sago, U. S. — Product of the *Sagus Rumphii*, or *sago palm*, indigenous in the East Indies, growing about 30 feet high. The sago resides in the pith of the trunk; this is agitated in water, to which it imparts its starch; this subsides, and is passed through a sieve, when the farina is deposited on standing, and then dried; this is *common sago*. It is in grains of unequal size, of a yellowish colour. The finest kind, called *pearl sago*, is refined by the Chinese; it is in small, round grains, whitish, hard, and sometimes translucent, with no odour, and a slight taste. It consists almost entirely of pure starch; insoluble in cold water; requires long boiling. — Uses and modes of preparation, the same as for tapioca.

Fig. 370.

CLASS XXIII.

DILUENTS.

Mild liquids, which dilute the contents of the stomach and bowels; and which, entering the blood-vessels, render the blood thinner, and, at the same time, dilute the secretions. Water is the only liquid, strictly speaking, which can be used for these purposes; water is, in fact, the great diluent of nature. The additions which are usually made, are for the purpose of imparting flavour, or rendering it more nutritive. Diluents are useful in inflammatory diseases,—in cases of acrid poisons, — as adjuvants to emetics, &c., also to restore a proper degree of fluidity to the blood. The demulcents form the best diluent drinks.

CLASS XXIV.

ANTACIDS.

MEDICINES which combine with, and neutralize acids. Their action is entirely chemical. Although all salifiable bases are antacids, the only ones employed remedially are the alkalies, alkaline earths, and alkaline carbonates. They do good by removing excess of acid in the stomach and bowels, which is frequently the cause of disease, as colic, diarrhœa, &c. They are also useful in the uric acid diathesis, where there is a tendency to gout, and gravel.

MAGNESIA. — One of the most valuable of the antacids; — very powerful, in consequence of its low combining number; used extensively in the colics, and diarrhœas of children, either alone, or combined with rhubarb or calomel; also in sick headaches, gout, and gravel. Dose, gr. x to ʒj. — The *carbonate* is given in double the dose.

CARBONATE OF SODA. (*Sodæ Carbonas*, U. S.) — Procured from the ashes of sea-weeds, in the impure forms of *kelp* and *barilla;* generally manufactured from the sulphate, by decomposing it with carbonate of lime. It is in large, rhomboidal crystals, efflorescent, very soluble in water; taste, alkaline; unequal in strength. Dose, 20 to 30 grs.;—of the dried salt, 5 to 10 grs.

BICARBONATE OF SODA. (*Sodæ Bicarbonas*, U. S.)—*Supercarbonate of Soda.*—Prepared by passing carbonic acid gas through a solution of the carbonate, and crystallizing at a low heat. Usually occurs as a white powder, and contains some sesquicarbonate; — not so soluble as the carbonate, but less disagreeable to the taste. Given in dyspepsia, &c.; also used in making soda and Seidlitz powders. — Dose, gr. 10 to ʒj.

CARBONATES OF POTASSA. — Already spoken of under *Diuretics.* As antacids, the *carbonate* is given in the dose of 10 to 20 grains; the *bicarbonate,* in from 20 to 40 grains. — The *infusion of hickory ashes* is sometimes used as an antacid: it owes its efficacy to the carbonate of potassa which it contains.

Liquor Potassæ, U. S. — Solution of Potassa is an excellent antacid in the diarrhœas of children; also in dyspepsia, used with bitters.

Lime. (*Calx*, U. S.) — Used medicinally only in solution, under the name of *lime-water* (*Liquor Calcis*, U. S.);—made by dissolving lime in water, and keeping it in well-stopped bottles, with a portion of lime undissolved, in order that it may be always saturated. It is colourless, of an alkaline taste and reaction; combines with the carbonic acid of the air, and forms a pellicle of the carbonate. Used generally in combination with fresh milk, as a remedy for irritable stomach, — a tablespoonful of each, taken every half hour. Externally, in combination with linseed oil, as a liniment for burns.

The *carbonate* is used internally in the form of *prepared chalk*, and *prepared oyster-shells.* Prepared chalk (*Creta Præparata*, U. S.), occurs in the form of small, white, conical masses, insoluble in pure water, somewhat soluble in carbonic-acid-water. It is astringent as well as antacid, and is very useful in diarrhœas accompanied by acidity—particularly in children; dose, 5 to 20 grains, every hour or two. The *Chalk mixture* (*Misturæ Cretæ*), is made by rubbing up chalk with sugar and gum, and adding cinnamon-water. — Chalk is sometimes applied externally as an absorbent.

Prepared oyster-shells (*Testa Præparata*, U. S.), are made from the common shells by grinding, &c., as for prepared chalk. They differ from it only in containing a little animal matter.

Uses.—The same.

The *precipitated carbonate* (*Calcis Carbonas Præcipitatus*, U. S.), is made by the reaction of carbonate of soda on a solution of chloride of calcium. It is a fine, white powder.

Ammonia. — A stimulant antacid, given in aqueous or alcoholic solution. The *Liquor Ammoniæ* and the *Spiritus Ammoniæ* are seldom used internally, in the undiluted form. The *Spiritus Ammoniæ Aromaticus* is an excellent stimulant in languors, faintings, flatulent colic, &c. *Carbonate of ammonia* is also antacid.

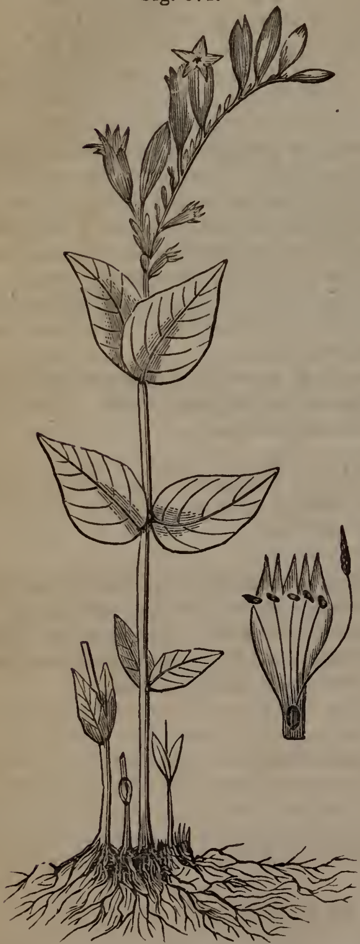
CLASS XXV.

ANTHELMINTICS.

Medicines which destroy, or expel worms from the alimentary canal. Some act by a direct poisonous influence upon the worms, causing their death; others, by a purely mechanical method; others, again — as the drastic cathartics — through the increased amount of mucous exhalation produced.

Pink Root. (*Spigelia*, U. S.)—Product of *Spigelia Marilandica*, an indigenous, herbaceous perennial, growing in the Southern States. The root is the officinal part. It consists of numerous branching, wrinkled fibres, attached to a caudex; colour, brownish-yellow externally; odour, faint; taste, sweetish and bitter. It contains a fixed oil, and a peculiar bitter extractive, which is the active principle, and some others. Large doses are cathartic and sometimes narcotic. It ranks high as an anthelmintic, destroying the worms. Given in powder and decoction; dose of powder for a child two to four years old, 10 to 20 grains; often combined with calomel. The infusion (*Infus. Spigeliæ*, U. S.) made with ℥ss to Oj. Often combined with senna, to insure its purgative effect. The *Extractum Spigeliæ et Sennæ Fluidum*, U. S., is an excellent preparation; dose, f℥j–ij.

Fig. 371.



Wormseed. (*Chenopodium*, U. S.)—Seed of the *C. anthelminticum*, or Jerusalem oak, and also of *C. ambrosioides*, indigenous perennial plants, growing throughout the United States. The seeds are about the size of a pin's head; of a greenish-yellow colour, pungent taste, and a peculiar aromatic odour; virtues depend on a volatile oil. They are an excellent anthelmintic; peculiarly adapted to expel the lumbrici of children; best given as an electuary with molasses; to be administered for several successive days, and then followed by a cathartic; dose, ℈j–ij.

The oil is of a light yellow colour, grows darker by time; given in the dose of 5 to 20 drops.

Pomegranate Bark. (*Granati Radicis Cortex*, U. S.) — The bark of the pomegranate root is powerfully anthelmintic; useful in the expulsion of the *tape-worm;* best given in decoction made by boiling ℥ij in Oij water, down to Oj; dose, one-third, to be taken every half hour.

Pride of China. (*Azederach*, U. S.) — Bark of the root of the *Melia Azederach*, a beautiful tree, growing in the Southern States. The bark is most powerful in the fresh state; taste, bitter and nauseous. In full doses, it is emeto-cathartic; overdoses are narcotic. Best given in decoction, repeated for several days, and then followed by a cathartic.

Male Fern. (*Filix Mas*, U. S.) — Root of the *Aspidium Filix Mas*, growing in Europe and North America. The root is long, cylindrical, and flexible, covered over with the remains of the leafstalks. As found in the shops, it is very apt to be deteriorated. Colour, externally, brown; odour, feeble, but peculiar; taste, astringent and nauseous. It is slightly tonic, and very astringent; also anthelmintic; used to expel the tape-worm. Not much used at present. Dose of powder, ʒj to ℥iij; of the oil, 30 to 40 drops; of the ethereal extract, gr. x–xx.

Cowhage. (*Mucuna*, U. S.) — Legumes or pods of the *M. pruriens*, a climbing West India plant. The pod is about four inches long, shaped like an italic *f*, covered over with brown, bristly hairs, which easily separate when handled, and produce intense itching. *Used* by steeping the pods in molasses or honey, and then scraping off with a knife. It acts as an anthelmintic in a mechanical manner, — the spiculæ, adhering to the worms, causing them to loose their hold on the intestine. Dose, of the electuary, a teaspoonful to a tablespoonful, to be given for several successive mornings, and then followed by a cathartic.

Oil of Turpentine. — Powerfully anthelmintic in large doses; particularly useful in expelling tænia; its purgative operation must be always insured by combining it with, or following it by castor oil. Dose, f℥j to f℥ij. In smaller doses, it is very efficacious in removing the ascarides of children, to whom it may be given in combination with castor oil, or else by enema.

Tin. (*Stannum*, U. S.) — Used in the form of powder, which is prepared by melting tin, stirring while cooling, and then passing through a sieve; believed to act mechanically; used chiefly to expel

lumbrici, and tænia. Dose, ʒj to ʒij, repeated, and then followed by a brisk cathartic.

Calomel.—An excellent anthelmintic for children; best administered by giving a grain or two every night, or every other night, and following, in the morning, with a dose of castor oil and oil of turpentine. It, no doubt, acts through the agency of the bile which is poured out.

The *seeds* of the common pumpkin (*cucurbita pepo*), and a *fixed oil* obtained by expression from the seeds, have been employed with success for the removal of tænia; ʒss, repeated once or twice, is the dose of the oil, to be followed by castor oil.

Kousso, (the flowers of *Brayera Anthelmintica*, a plant of Abyssinia), are also used in tænia. A decoction, (℥i–iss to water Oi, boiled to Oss), is the form of administration recommended.

HAND-BOOK

OF THE

PRACTICE OF MEDICINE.

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PRACTICE OF MEDICINE.

Diseases may conveniently be divided into two great classes, *general* and *local*. The former includes those which affect the whole system at the same time; the latter those which affect some particular structure or function, and in which the general or constitutional phenomena are only secondary.

CLASS I.

GENERAL DISEASES.

This class comprises all the idiopathic fevers, together with the exanthematous or eruptive fevers, and to them we may add Rheumatism and Gout.

FEVERS.

The term *Fever* is employed in two different senses,—one to denote a peculiar state of the system, which may be present in any disease, and which exhibits itself chiefly by an increase of temperature; the other, to signify certain affections, in which the above, with other symptoms, are usually present; thus we speak of intermittent, remittent, and typhus fevers, as special disorders, whilst, in the more general sense, we speak of an individual having *fever*, as an accompanying symptom of a pleurisy, a pneumonia, &c. The importance of bearing in mind the above distinction between the application of the term "fever," will be obvious, when it is recollected, that in many of the so-called *fevers* the *symptom* fever may be entirely absent; this is familiar in the cold stage of an intermittent, or as a characteristic condition of fatal cases of adynamic or pernicious fevers.

In fevers there is usually more or less derangement of all the functions, the most striking phenomena being sensorial or nervous irregularity, increased heat of skin, increased frequency of pulse, and loss of appetite.

Various premonitory symptoms usually intimate its approach. These constitute its *forming stage.* They are a sense of lassitude and wea-

riness, general aching of the body, slight chilliness, and occasional headache, with disinclination for food. These symptoms may continue for days, and are sometimes wholly absent. They are most apt to occur in protracted fevers, as the typhus and typhoid.

The *cold stage* or *chill* is the first decided evidence of the existence of the disorder. Its approach is sometimes gradual, and sometimes sudden, and it varies much in intensity. The sensation is, at least partly, nervous, though it is often attended with some reduction of the temperature of the body. The pains which accompany it are purely of a nervous character. Its duration is very variable, in some cases not exceeding a few minutes; in others, continuing for hours, or even days.

The cold stage is gradually merged into the *hot stage*, in which there is an actual increase in the temperature of the body, rising occasionally as high as 107°; along with this, there is an increase in the fulness and frequency of the pulse, varying however very much in this respect, occasionally reaching as high as 150 or 160 per minute. There is also generally a flushed face, together with more or less pain of head, and increase of sensibility to light and sound.

The *secretions* are always deranged in fever; usually they are diminished, or entirely suppressed.

The *declining stage* of fever is frequently marked by the occurrence of profuse evacuations from the skin, kidneys, bowels, &c.; these are termed *critical discharges*.

The *duration* and *course* of fever varies; it occasionally runs through all its stages, and terminates in a day; in which case it is called *an ephemera*. Again it may return, after an interval differing in length, when it is named *intermittent*. Again it may partially decline, and afterwards return with its former intensity, when it is called *remittent;* and finally, it may continue with little or no tendency to remission, in which case it would receive the name of *continued fever*.

Two very opposite *grades* of fever exist; the one denominated the *inflammatory* (*synocha* of Cullen), marked by an increased vital activity; the other, the *low*, *typhous*, or *adynamic*, characterized by a feeble condition of the vital forces. The term *synochus* was used by Cullen to designate a fever which was inflammatory at the commencement, and typhous towards its close.

The division of fevers into *idiopathic* and *symptomatic* indicates a difference in their *cause*. The former term is applied to those which arise without any obvious local cause; the latter denotes those which are produced by inflammation, or some other local agency. Many eminent pathologists have denied the existence of idiopathic fevers, referring them always to some local irritation or inflammation.

Idiopathic fevers are often *accompanied* by inflammation;—thus inflammation of the mucous membrane of the throat accompanies scarlatina; inflammation of the cerebral membranes, or lungs, or intestinal mucous membrane, may occur together with typhoid; hence some emi-

nent physicians have persuaded themselves, that typhoid is not an idiopathic fever, but that it is symptomatic of a local inflammation.

In a symptomatic fever, the local inflammation begins first—in an idiopathic fever, on the contrary, the feverish symptoms begin first, and may continue some time before any local disease appears, if it appear at all.

Idiopathic fevers are most commonly caused by some poison which gets into the blood. Their chief kinds are the intermittent, remittent, continued, and exanthematous; each of which has many varieties.

Symptomatic fevers may be of an acute inflammatory type, or hectic, or typhoid. We may observe here that an intermittent fever is sometimes symptomatic of disease in the urethra, and remittent fever of worms and accumulations of sordes in the alimentary canal.

CLASSIFICATION OF FEVERS.

1. Irritative Fever.
2. Miasmatic fevers.
3. Yellow fever.
4. Typhoid, or enteric fever.
5. Typhus.
6. Small pox or variola.
7. Vaccine disease.
8. Chicken pox.
9. Measles or rubeola.
10. Scarlatina.
11. Erysipelas.
12. Plague.

Dr. Dixon[1] assumes the establishment of the following distinct types:

I. The Periodical: Intermittents and remittents generally.

II. The Continued: Comprising 1, Yellow Fever; 2, Typhus Fever, Typhoid and true Typhus, the Epidemic Fever of Great Britain, Simple Fever, or Ephemera, Relapsing Fever of Jenner; 3. Catarrhal Fever, Influenza; 4. Pneumonia Typhoides, Spotted Fever.

III. The Exanthematous: 1, Variola; 2, Measles; 3, Scarlatina; 4. Erysipelas; 5, Dengue, etc.

Of several of these there are varieties, as, for instance, we may have inflammatory, or congestive intermittents or remittents. Some are propagated by contagion, and are hence called *contagious;* some have the property in common that they are attended with an eruptive affection, and are denominated *eruptive*, or *exanthematous fevers.* These are, in many instances, interchangeable terms; most contagious fevers being exanthematous, and most of the exanthemata contagious. Each, however, is distinct individually.

IRRITATIVE FEVER.

By this is meant a simple fever arising from any irritating cause, but unattended with local inflammation. Usually its duration is very short,—from one to five or six days. If it extend beyond this it is probable that some local inflammation has been developed. It evinces a tendency to remit.

[1] Elements of Medicine, Philada., 1855.

The *symptoms* are those of fevers generally, only milder. In infants it may commence with a convulsion, though this is not very common; during the paroxysm there may be, in them, drowsiness even approaching to coma, rendering it liable to be mistaken for hydrocephalus.

Causes.—Any cause producing irritation. In children, the causes are more frequent—such as teething, crude ingesta, worms, &c. Hence it has been called *worm-fever.* But, again, it is often nothing more than a symptomatic fever depending upon some phlegmasia, as enteritis, pneumonia, &c.

Treatment.—A mild saline cathartic, followed by a refrigerant diaphoretic. For children, a purgative dose of calomel is especially indicated. To allay nervous excitement, which is apt to be present in children, we may use sweet spirits of nitre, Hoffman's anodyne, garlic poultices to the feet, and the warm bath. If crude ingesta be suspected, give a moderate dose of ipecacuanha. The *diet* should be low; for children, cold gum-water is the best.

The convulsions in children are not usually dangerous. They are to be treated by applying cold to the head, and revulsives to the feet; and, if persistent, by leeches to the temples or behind the ears.

MIASMATIC FEVERS.

Under this name it is convenient to arrange three distinct fevers. *Intermittent, remittent,* and *pernicious,* because they all depend upon an identical cause, *miasma.*

The term *miasma* signifies *exhalation.* For want of positive knowledge on this subject, the term is here used to signify *marsh exhalations.* They are known only by their effects, all attempts to isolate and analyse them having utterly failed. They have been suspected, but never proved, to be due to cryptogamous, or animal germs. The concurrence of heat, moisture, and vegetable decomposition seems to be requisite for their production. The temperature must be above a certain point, and must be continuous for a definite time. Thus in Quebec, St. Petersburg, and other northern cities, although the heat of summer is often excessive, it is too brief to cause their appearance. Their intensity increases in proportion as we approach the equator, where they assume great malignancy. They cease to be developed after a decided frost,—another proof of their vegetable origin. They never originate in the midst of the ocean, though often along the coast; likewise in low situations subject to the overflow of rivers, or in the flooding of meadows. Cities are nearly or quite exempt from them. They evince a great affinity for moisture, hence the greater liability to exposure early in the morning and in the evening, on account of the condensation of the vapour upon the surface of the earth.

Miasmatic fevers sometimes prevail *epidemically,* a fact which it is

difficult to account for. Negroes are less susceptible to their influence than whites.

INTERMITTENT FEVER.

A disorder characterized by febrile paroxysms recurring at stated intervals, and by the absence of fever between the paroxysms.

Varieties.—The three most common varieties are—

1. The *quotidian*, in which the fit comes on every day, generally in the morning, and lasts about ten or twelve hours.

2. The *tertian*, which comes on alternate days, generally about noon, and lasts till evening.

3. The *quartan*, which comes on once in three days, usually in the afternoon. It has the longest cold fit, but the shortest paroxysm altogether. There are also *double quotidians*, having two paroxysms every day. *Double tertians*, having a paroxysm every day, but at different hours. Sometimes there are two paroxysms on one day, and none the next: this is called a *duplicated*, or *double tertian*. The *triple tertian* has two paroxysms on one day, and one on the intervening. Dr. Dixon also describes a *tertiana triplicata*, in which *three* well marked paroxysms occurred on every alternate day. In *double quartans*, out of three days, two have each one paroxysm, and the other none. Of all these varieties, the *double tertian* is the only one which often occurs.

A distinction is made between the *interval*, and the *intermission* of an ague. The interval, is the space between the beginning of one paroxysm, and the beginning of the next; which in the tertian is forty-eight hours; the intermission, is the space from the *end* of one paroxysm, till the beginning of the next: in other words, the time when the patient is free from the disease; which in the tertian is about forty-two hours. This is also called *apyrexia*. The *type* of the fever has a reference to the length of the interval. Besides the varieties mentioned above, there are *quintans*, *sextans*, *octans*, &c., but they are very rare.

Seasons of occurrence.—The *quotidian* commonly occurs in spring; the *tertian* at the end of summer, and beginning of fall; the *quartan* later in the fall.

Symptoms.—An intermittent consists of three stages:

1. The *cold stage.* — This begins with chilliness and constriction of the whole body; the nails are blue; the skin is rough (*cutis anserina*), and there are violent shiverings, and chattering of the teeth, headache, and backache, quick, small pulse, oppression at the precordia, and sometimes vomiting. After these have lasted some time, there comes the

2d, or *hot stage*, beginning with flushes of heat, which gradually increase, till the skin becomes very hot and dry, the face flushed, the temples throbbing, and the pulse full and frequent. After a duration of from three to eight hours, comes the

3d, or *sweating stage.* — Perspiration begins on the head and face, and becomes profuse all over the body; and the urine deposits a copious lateritious sediment. Now, in uncomplicated cases, the patient feels well, but weak, till the next recurrence of the fit. Sometimes one of the stages is wanting, as for instance the cold stage; this form is called a *dumb ague.* Sometimes the fever is wanting, or has neuralgic pains substituted for it. The sweating stage is also sometimes absent, or is supplied by copious urination, or diarrhœa.

Causes. — Marsh miasmata are the essential causes, though cases incidentally occur which are not traceable to this cause. The disease does not proceed from lands which are inundated, as much as from those which *have been* flooded and are drying. It is more virulent in hot climates than in temperate — in low situations than in high; the upper stories of a house being much more healthy in aguish districts than the lower. It is carried about by winds, but interrupted by trees; and is always more dangerous by night than by day. It is far more likely to attack persons exhausted by fatigue, intemperance, or illness, than the healthy: these, therefore, are predisposing causes. Cases sometimes occur, which proceed obviously from some temporary irritation, such as the introduction of instruments into the urethra, indigestible food in the stomach, worms in the intestinal canal, &c.

Treatment in ordinary cases.—In most cases it is well to commence with an active cathartic, such as the comp. cathartic pill, so as to clear the bowels. If the stomach is very foul, an emetic may be used, though it is not essential. During the cold stage, warm drinks of tea, or wine-and-water, if the patient be feeble, or addicted to its use, hot foot-baths, warm bed, frictions of the spine. The tourniquet, applied to the leg and arm of the opposite side, has also put an end to the cold stage. Opium has also been used with excellent effect. During the hot stage, cool drinks and refrigerant diaphoretics; after the sweating, let the skin be rubbed dry with warm towels.

When the paroxysm is over, begin with some antiperiodic remedy, to prevent its recurrence. The best is *sulphate of quinine,* of which from two to four grains should be given every four hours, either in pill or in solution with a few drops of dilute sulphuric acid, until from twelve to twenty-four grains are taken in the apyrexia. Under some circumstances, it may be necessary to administer the whole dose, either immediately before or after the paroxysm; as, for instance, when the apyrexia is exceedingly short, as in the quotidian. Upon the whole, however, it is best, if possible, to introduce it into the system gradually.

The remedy should be continued in gradually decreasing doses, for ten days or a fortnight after the last fit, as the complaint is very apt to return on the seventh, fourteenth, or twenty-first day after the attack.

If the quinine is rejected by an irritable stomach, it may be in-

jected into the rectum in solution in distilled water, with a drop or two of laudanum; or applied endermically to the epigastrium.

If the quinia cannot be procured, or if it does not produce good effects, the next best remedy is Fowler s solution, in doses of ♏ v.—x. ter die. Other remedies are, willow bark, piperine, sulphate of zinc, ammonia, sulphate of copper, tinct. of sage, and all the vegetable bitters and astringents; but they are much inferior in virtue to the quinine. The sulphate of cinchonia has recently been substituted for quinine, in the same doses. It is cheaper and apparently equally efficacious.

Opium given in a full dose sometimes puts off the fit, if given just before it is expected; and it is also of great use to shorten the hot stage.

Bloodletting, in the cold stage, was recommended by Dr. Mackintosh, but in ordinary cases is now repudiated by most physicians. It may, however, be necessary in the violent agues of hot climates, when there is great internal congestion, or delirium and cerebral excitement.

The great congestion in the abdominal veins which occurs during the cold stage, is very apt to produce enlargements and induration of the liver, and especially of the spleen, the tumour formed by which is commonly called *ague cake;* and the obstruction to the venous circulation caused by these is liable to induce dropsy.

REMITTENT FEVERS.

Syn.—Bilious fever.—Bilious remittent fever.

In this form of fever, the febrile phenomena evince striking exacerbations and remissions, one paroxysm occurring in the twenty-four hours. It differs from intermittent fever in the intermission not being complete. It is *caused* essentially by marsh miasmata. It is most common in the middle and southern sections of the United States, although it occurs in all parts lying between the northern lakes and the Gulf of Mexico. The localities that it most frequents are the valleys of streams, the borders of lakes and ponds, the neighbourhoods of marshes, and the western prairies. The seasons in which it occurs are the summer and autumnal months.

Symptoms.—For several days previous to the invasion, the patient complains of uneasiness at the epigastrium, lassitude, pains in the back, limbs, and head, and restlessness at night. The invasion is attended by coldness of the surface, and frequently by shivering; this coldness is soon superseded by heat, by febrile flushes, or by alternations of heat and cold, by nausea, and occasionally by vomiting. The pains in the head, back, and limbs now become aggravated; the mouth is clammy and dry; the tongue white or loaded; the surface very hot and parched; the face flushed; and the pain of the head attended by a feeling of distension and throbbing, often passing into delirium. The pulse is full, hard, and frequent; thirst is urgent; the bowels consti-

pated; and the urine scanty and high-coloured. There is usually more or less epigastric tenderness, with nausea, and often vomiting. The symptoms generally continue from about ten or twelve to eighteen hours, when perspiration breaks out; the pulse falls in frequency and strength; delirium disappears, and the irritability of the stomach subsides; there is merely a remission or abatement, but no intermission of the febrile symptoms. The remission is exceedingly variable in duration, in some cases not lasting more than two or three hours, in others a whole day; being shorter or longer, according as the type of the fever may be quotidian or tertian. Another paroxysm then occurs, but generally without any chill, running the same course and ending in like manner, each successive exacerbation becoming, generally, more severe and protracted, and each remission less decided.

The symptoms become now more violent. The remissions disappear; the skin becomes dry and harsh, or moist and clammy; the pulse small and irregular; the tongue black and crusted; and the vomiting, and pain at the epigastrium, more constant. In the most unfavourable cases, yellowishness of the skin occasionally supervenes. The bowels become irritable, the evacuations being watery, greenish, and, at last, almost black. The urine is scanty and high-coloured, or sometimes of a yellowish-brown colour. The headache is intense, accompanied often by vertigo, tinnitus aurium, and delirium.

The disease may run on thus for a time varying from the seventh to the fifteenth day, when it either declines with a profuse perspiration, a diarrhœa, or a general subsidence of all the symptoms, or else it runs on to a fatal termination. Sometimes it terminates in an intermittent; at others in a continued fever.

INFLAMMATORY REMITTENT FEVER.

This form differs but slightly from the foregoing in its symptoms and course. Violent determination to the brain characterizes the commencement of reaction in this variety; and inordinate affection of the mucous surfaces, the more advanced stages.

CONGESTIVE, OR MALIGNANT REMITTENT.

This is one of the severest and most fatal of endemic fevers. As its name implies the disease is of a malignant type from the commencement. It probably owes its peculiarities to the intensity, or concentration of the febrific poison. The great danger here is, that when the patient is raised, perhaps with great effort, out of the paroxysm, the practitioner may regard it as incipient convalescence, and neglect the precautions necessary to ward off the next, which may prove fatal.

Anatomical characters.—Inflammation of the stomach and bowels is perhaps the most frequent lesion. The glands of Brunner are often much developed, but Peyer's glands are unchanged. The membranes of the brain are sometimes inflamed, and sometimes there is conges-

tion. The liver is often enlarged, more or less softened, and, according to Dr. Stewardson, of a bronze or slate colour. The spleen is also enlarged and softened.

Complications. — *Gastro-duodenitis* is among the earliest complications of remittents; in the more advanced stages, *dysentery* occasionally comes on. Diseases of the *liver* and *spleen* are common attendants on remittents. *Determination of blood to the brain* often occurs early in the more severe forms, especially in that form of remittent fever which occurs during the heat of summer, and in large cities. In temperate climates, remittents are frequently associated with *bronchial* or *pulmonary affections.*

Treatment. — It was formerly the practice to commence with an *emetic*, but this is not required except there be indications of crude ingesta or an accumulation of bile in the stomach, as shown by frequent retchings, and a bitter taste in the mouth.

In all cases an active *cathartic* is indicated; calomel is the best, in the dose of ten to twenty grains, for an adult, to be followed in the course of four or five hours by some mild purgative; or else it may be combined with jalap or rhubarb; or the comp. cathartic pill may be substituted. If the bowels are very obstinate, purgative *enemata* should be used. After thorough evacuation of the bowels, gentle *laxatives* only are required.

Bleeding is only to be employed in cases of actual, or threatened inflammation, or active congestion. It cannot cure, or shorten *the fever.* Often topical bleeding may be preferred.

Diaphoretics are always indicated in the hot stage, the *effervescing draught* is the best, especially in an irritable condition of the stomach; it may be advantageously combined with tartar emetic and sweet spirits of nitre; or, the antimonial may be used alone, if the stomach will bear it. The neutral mixture and spirits of mindererus are also employed.

If the disease runs on beyond the seventh day, it will be proper to give calomel or blue pill, so as to produce gentle salivation, and Dover's powder at night.

Ordinary cases usually recover under the above treatment, but the best plan is to cut short the disease at *once*, by means of quinine, as soon as a decided remission occurs; at which time from 12 to 24 grs. should be given. When a paroxysm of great violence has been subdued, and there is danger that the next may prove fatal, recourse should be had to the sulphate of quinia, no matter how short or imperfect the remission may be. The quantity must be sufficient to bring the system under its influence before the next paroxysm. The remedy should be continued until two daily paroxysms have been prevented; after which the patient may be considered safe. Cold sponging is often very refreshing to the patient, but should be discontinued if he complain of chilliness. Any complication that may be present will require distinct treatment, according to the organs that are affected.

During convalescence gentle *tonics* may be administered.

In the inflammatory form, quinine cannot be used; the main reliance, then, is upon calomel in large doses, as a sedative, and a general antiphlogistic treatment.

INFANTILE REMITTENT FEVER.

This disease, though not of miasmatic origin, is conveniently treated of in this place. It usually attacks children from nine or ten months to twelve or thirteen years old. It generally arises from errors in diet, and accumulation of morbid matter in the primæ viæ. It may also arise from obscure miasmata. Writers in the three last centuries imputed this fever to worms, hence the term "*worm fever;*" but the presence of worms is rather a complication than a cause of the affection.

Symptoms.—This affection commences gradually; the bowels being irregular, generally costive, but occasionally relaxed and irritated. The child becomes feverish and drowsy towards evening, but generally seems pretty well in the morning. The appetite is variable; the pulse ranges from 100 to 140; and the tongue is loaded. After these symptoms have lasted for several days, a distinct chill or rigor is sometimes observed; vomiting ensues; and a more violent paroxysm of fever, drowsiness, flushed cheeks, and shooting pains through the abdomen and head, follow. The child constantly picks its lips and nose; and occasionally stiffness of the neck, great sensibility of the general surface, and tenderness in the course of the spine, are observed. In the more advanced stages, the ingesta are either thrown off unchanged, or passed undigested from the bowels. In very young children, convulsions come on; in those of more advanced age, delirium often attends the night exacerbations. This is the most common form of the disease.

Acute variety.—This form may occur rather suddenly. The bowels are irregular, commonly costive; the evacuations are morbid and offensive; the urine turbid, pale, or milky; and the tongue is loaded, especially at the base. Fever supervenes, and is ushered in by rigors or chills, the child being hot and restless at night. During the exacerbations, the child is drowsy; and if it sleeps, moaning, starting, and even screaming, or incoherence, are observed; sometimes with vomiting, there is flatulent distension of the abdomen, accelerated breathing and cough. The face is usually flushed; the abdomen and palms of the hands hotter than other parts of the body; and the pulse varies from 120 to 160, according to the age. Occasionally the paroxysm terminates in a slight perspiration, which is often partial; the child falls into a quiet sleep, and the pulse sinks in frequency.

Diagnosis.—In infantile remittent fever the cerebral symptoms do not appear until near the close of the disease; in hydrocephalus, they

invariably occur before the end of the first week, and oftentimes sooner. The acceleration of the pulse, the remissions and the diarrhœa, which are always constant symptoms of infantile remittent fever, will serve to distinguish it from acute hydrocephalus, in which the bowels are always constipated from the commencement of the disease, and the pulse occasionally slow.

Chronic form of remittent. — This form either makes its approach insidiously or follows the acute. The child wastes, the abdomen enlarges, the breath is offensive, and the strength fails. The tongue is white or loaded, but moist, and has often a strawberry-like appearance; the bowels are generally costive, and the evacuations are always unhealthy. The pulse is usually about 100 in the day, but rises to 140 in the evening. There is generally one exacerbation in the twenty-four hours, and it seldom appears before evening, lasting until morning, and terminating in sweats. If the disease be not removed, tympanitic distension of the abdomen, emaciation, harsh discoloration of the skin, enlarged mesenteric glands, chronic diarrhœa, and lientery, supervene.

This affection is liable to be mistaken for chronic inflammation of the pia mater in children.

Treatment.—If the affection be acute, and the child strong, leeches should be applied to the epigastrium, calomel and ipecacuanha ought to be given at night, and a mild aperient draught in the morning. If the bowels are not evacuated by these means, an enema should be given; equal parts of castor oil and oil of turpentine in water-gruel form the best enema in these cases. The calomel and ipecac. powder should be repeated every night, or on alternate nights; and a purgative mixture be given in the morning. When the evacuations have been improved by these means, mild tonics may be employed; of these, the infusions of cinchona, cascarilla, and of valerian, form the best; stimulating liniments, and other counter-irritants, should be applied to the abdomen. The *foot-bath*, some mustard-flour being added to the water, will be found useful at bed-time. Small doses of sulphate of quinine may be exhibited; and if the disease assume the adynamic form, small doses of chlorate of potassa in an infusion of valerian or of cinchona may be given with advantage. Change of air, especially to a dry and elevated situation, should be recommended. Warm clothing, frictions of the surface, and light, but nourishing diet, are also very beneficial. During the complaint, farinacea, and weak broth, are the most suitable food. Where the disease has produced mesenteric obstruction, small doses of iodide of potassium may be exhibited. When convalescence is established, the iodid. ferri or Huxham's tinct. will be found useful tonics.

HECTIC FEVER.

Hectic fever is a remittent fever, *rarely, if ever, idiopathic,* and not of miasmatic origin, but depending upon some local source of irritation,

especially if attended with an exhausting discharge; perhaps arising from the absorption of diseased secretions.

Symptoms. — Hectic fever is attended with great and increasing debility, a weak, quick, and rather hard pulse, hurried respiration on any exertion, and increased heat of the skin. The exacerbations, which are at first slight, soon become more evident, particularly in the evening; are preceded by a slight or marked chill; are attended by increased heat, which is most evident in the hands and face, the skin being at first dry; and terminate in a free, profuse perspiration, especially the evening paroxysm, which subsides in this manner early in the morning. The bowels are at first costive, but soon become relaxed, and colliquative diarrhœa comes on: the urine is various, generally it is pale, and does not deposit; more rarely, it is high-coloured, and yields a lateritious sediment. While there is a general pallor of the surface, the cheeks present what is very aptly styled the "hectic blush." As the disease advances, the whole frame becomes emaciated; the eyes are sunk in their orbits, but are brilliant and expressive; the ankles and sometimes the legs are œdematous, and the sleep is feverish and disturbed. At last, the diarrhœa and colliquative sweats become more abundant, the respiration more hurried, and the debility so great that the patient expires while making some slight exertion.

Treatment. — This must essentially depend on the cause or pathological state which occasions the hectic fever. Where there is disease of the digestive mucous membrane, the treatment consists in strict attention to the diet, in improving the condition of the secretions, in the administration of mild tonics, and the occasional exhibition of saline refrigerant diuretics, and diaphoretics. Gentle astringents, mineral acids, &c., are useful. Of the acids, sulphuric given in infusion of roses is to be preferred. Anodynes in the form of conium, hyosciamus, and humulus or opium are occasionally given.

PERNICIOUS FEVER.

Syn.—Congestive fever.—Pernicious intermittent.—Pernicious remittent.

This term should be restricted to an affection, in which there is great and sudden prostration or deprivation of the nervous power; or, to use a customary phrase, in which the *innervation* is extremely and most dangerously defective or deranged. (Wood.)

This modification of miasmatic fever may be intermittent, remittent, or continued. It is only, however, when of two or three days' duration, that it can be called continued, for if the disease persist, it will almost certainly become paroxysmal. Most frequently it is intermittent or remittent, the last most commonly according to Dixon; and although often a quotidian, is more frequently tertian in its type.

Symptoms.—In some cases the organic functions are most affected; then the evidences of disease are presented chiefly in the organs of

digestion, respiration, circulation, calorification, and secretion. In other cases the blow falls upon the animal functions, then the brain is the organ most affected. Of the organic functions, sometimes one is selected in preference to the rest. Thus the force of the morbific cause appears to fall, in some instances upon the heart, in others, upon the alimentary canal, in others again, upon the surface of the body, either in its function of secretion or calorification.

Sometimes it approaches like an ordinary intermittent, at others, with its own peculiar features. It may occur at any hour of the day or night.

When the disease is fully formed and exists primarily in the organic functions, the face and hands are of a livid paleness, the features shrunk and expressive of alarm, the skin contracted and shrivelled like a washerwoman's, the extremities, the trunk, and sometimes even the breath are cold. The surface is, at times, moistened with a clammy perspiration, or bathed in a profuse sweat. The tongue is pale and cold, sometimes dry, sometimes unaltered; there is epigastric tenderness, with great internal heat and intense thirst. Nausea and incessant vomiting are present, with constipation, or the reverse. In the latter case the discharges consist of bloody serum, sometimes of blood, either coagulated or not. The respiration is characteristic, the breathing consists of deep sighs, and with two inspiratory efforts to one expiration. Sometimes it is hurried, irregular, and panting. The pulse is small, irregular, sometimes corded, but oftener feeble, fluttering, and sometimes intermittent. It is almost always frequent, amounting to as much as 120 or even 160 in a minute. With all these symptoms there is great restlessness, the patient attempting to arise from his bed to reach the door or window.

The above symptoms are those which accompany the chill.

The duration of the paroxysm varies; sometimes it will extend over two or three days, mingled with attempts at reaction, sometimes it will last but a few hours, and then reaction comes on, though in no degree equal to the preceding depression, and the patient seems as if about to be restored to health. At other times a slight degree of fever remains; it is only a remission that has taken place; again, it may approach more to an *intermission*.

If not arrested, the same train of symptoms recurs the next day or the day after with increased violence, the second paroxysm often proving fatal, though sometimes a third occurs, before death takes place.

Sometimes the whole force is spent upon the heart, then the prominent phenomena are those of excessive prostration of the circulation. In some cases coldness is the prominent symptom; in others an ordinary intermittent paroxysm runs its course and ends in profuse and exhausting perspiration, during which the pernicious symptoms appear. When the animal functions are affected the paroxysm usually begins with drowsiness, loss of memory, confusion, gradually

passing into deep coma, or an apoplectic state with stertorous respiration. Pulse full, and either faster or slower than in health. Sometimes convulsions are present. In some cases coma is preceded by delirium.

Cause.—The cause is undoubtedly the same as that of ordinary intermittents and remittents. What it is that gives rise to its peculiar character is unknown; probably a more intense action of the poison, or a greater susceptibility to its influence. The danger does not arise from the *congestion*, but from the *want of innervation*. Its localities differ from those of ordinary bilious fever; while the latter occupy the table lands, the pernicious fevers prevail especially in the low lands skirting the rivers.

Prognosis.—Exceedingly unfavourable; three-fourths of the cases, when not properly treated, die. Sometimes whole settlements are swept off by the disease. If seen during the first or second paroxysm the danger may be averted.

Treatment. — The first indication is to bring about a reaction as speedily as possible. One of the most obvious remedies is artificial heat; sinapisms to the extremities and abdomen, or along the spine, and frictions with turpentine or cayenne pepper should be used. Opium is useful for its stimulating and anti-emetic properties, and for its influence in arresting alvine discharges; it is best administered in substance, but should not be used when there is any affection of the brain, as shown by active delirium or stupor. Internal stimuli should also be administered; of these the sulphate of quinia is the best, and may be given even in the paroxysm before reaction. It should be used, however, in decided doses, and may be employed in any prostrate case, in which it can be borne by the stomach. Another remedy decidedly called for is calomel, and it may be advantageously joined with both quinia and opium. The internal administration of cayenne pepper is also of great benefit; it may be taken in five-grain doses. The proportions of these remedies must vary to suit the circumstances; so also must the articles employed. If these means fail to bring about reaction, wine or brandy may be given: cold affusion is also recommended, but it should not be carried too far. When coma is present, blood should be taken by cups, or from the arm, if admissible. The treatment in the intermission or remission should be the same as in ordinary intermittent, excepting that the sulphate of quinia should be given in much larger doses, as it constitutes the main reliance. From thirty to sixty grains should be taken from the beginning of one paroxysm to that of the next.

COUNTRY FEVER.

This is a title given familiarly in the cities of the South, to a modification of bilious or malarial fever, originating in *transient* exposure to the intensely concentrated malaria of the low country; or by sleeping a night or two upon a rice plantation, during the summer or au-

tumnal months. The sudden heats of spring sometimes develope it as early as May, or even April. Additional malignity is often seen on moving during the latent period of the disease, to a city atmosphere.

The progress of the attack is irregular, and the remissions uncertain, both in time of occurrence and duration, as well as in degree. The type is exceedingly complicated, obscure and confused. A rapid succession of unexpected or accumulated exacerbations annoys, distresses and wears out the patient.

The *prognosis* is unfavourable in a large proportion of instances, and the mortality considerable. The strength yields rapidly under the exacerbations so quickly following each other, each more prostrating than its predecessor.

The *treatment* must be prompt and decided. Our best dependence from the very commencement is upon the combination of mercurial with the sulphate of quinine in efficient doses. Ten grains of each may be given at first, and half the quantity at intervals of two hours, until the bowels are moved, when the calomel may be omitted; continuing the quinine, however, until its usual effects are produced; which should be kept up for 72 hours at least, to prevent a relapse, which is very apt to occur.

Determination to important organs must be met by the active but prudent employment of revulsives. (See *Dixon's Elements of Medicine.*)

MILK SICKNESS.

Synonymes.—Trembles, Tires, Slows, Puking Fevers, &c.

This is a peculiar and strongly-characterized endemic disease of several localities in the West.

Symptoms, &c.—There are two forms in which we meet with this disease,—the acute, and subacute or chronic. To the first the name of *milk-sickness* is usually given, and to the latter the expressive title of *slows*. They are, however, the same disease, produced by the same cause, and differing in degree only. In the subacute form, the individual is languid, unable to make any exertion of body or mind, appetite variable, bowels rather torpid, palpitation of the heart, slight stiffness of the limbs, trembling, and nausea if any considerable exertion is made, or if taking food is deferred beyond the usual time. After a variable period, and unless removed by the sanative efforts of nature, or by a proper course of remedial treatment, the disease assumes the acute form. The individual is suddenly seized with extreme nausea, prolonged vomiting, faintness, and prostration; the temperature of the body and extremities falls below the natural standard; the skin often grows cold and clammy; great distress and anxiety are depicted upon the countenance, the patient experiencing an undefined and aimless dread; the breath acquires a peculiar fœtor; the tongue is swollen; the bowels become obstinately constipated, and strong pulsation is observed over the whole abdomen, but especially marked to the right of the um-

tilicus. Cephalalgia, tinnitis aurium, &c., are common accompaniments. The heart and large arteries beat with violence, whilst the pulse at the wrist remains almost natural. The tongue is in most cases but slightly coated or changed from its natural appearance. A complete retroverted action of the stomach comes on, and at every effort of vomiting a fluid is ejected of variable appearance: it is sometimes colourless, sometimes like soapsuds, at others like indigo, and in the last stage of cases that terminate fatally, it is of a dirty brown, with a dark-coloured sediment. But, in all, it has the peculiar smell of the disease, and is generally represented by the patient as having a sweetish and most sickening taste. As the malady advances, sharp pains in the limbs and neck are experienced; acute gastric pain also comes on, accompanied by a peculiar and intense sense of heat at the præcordium, causing the patient to call out loudly for water to allay the burning sensation.

The pulse now increases in frequency, the face and extremities alternately flush and become cold, evacuations of blood take place, and the vomiting becomes so violent that every article of diet, drink, or fluid medicine is ejected. During the intermission of vomiting, the patient usually lies upon his back, tossing his limbs about, and sometimes in a partially comatose state, but is at all times easily aroused when addressed. The irritability and retroverted action of the stomach continue throughout the disease, until convalescence restores the sufferer, or death closes the scene.

Nature, cause, &c.—Of the nature and direct causes of this disease, but little is known. When it first made its appearance in the western country, the inhabitants of the infected district were obliged to remove, or suffer terribly from its poisonous influence. It was at first supposed by many to be a variety of malarial fever, while others considered it a species of congestive fever, generated by a peculiar atmospheric miasma. More extended observations, however, showed that certain locations in the West have been, from their first settlement, and still continue to be, subject to this peculiar disease; whilst other neighbouring localities, have always been exempt; that wherever this disease prevails in the human species, the lower animals are liable to a peculiar and fatal disease, called *Slows* or *Trembles;* and that, in the human species, the origin of the disease is in some specific poison, obtained, in most cases, from the milk or flesh of animals that have fed on these infected lands. What is the local cause or specific virus which invades these districts, inducing the disease, we do not know; as no two that have experimented or written upon this subject agree.

Experiments upon the authority of Graaf, Simpson, and others, show that it may be caused by the flesh, milk, butter, cheese, &c., of animals affected with the poison, whatever that may be. Some have attributed the infection of the cattle to their having eaten of the Indian Hachy, or of some species of Rhus, or a peculiar fungus, as the mushroom, &c. Others contend that it is of mineral origin, tracing it

to certain poisons existing in the soil, as arsenic, cobalt, &c.; while another party think it is dependent upon some aerial poison. Accounts conflict, as each observer judges from the prominent features of his own locality, which may differ in every respect from that of another.

That it is not caused by the water, of which the cattle drink, is shown by the fact, that the disease appears in narrowly closed districts, as sugar orchards, where there is no water; and, moreover, water, in which the poisoned meat was boiled, remained unaffected, while the beef still retained its poisonous properties; thus fairly proving that the poison is not soluble in water.

The theory of the vegetable origin of this malady is strongly confirmed by the following facts. The disease makes it appearance in all kinds of soils, though *cultivation* generally *destroys* the poison. The cause, whatever it is, affects the cattle grazing at *night*, and even during the day, the *woods* are dangerous to them. Those animals that have been gradually accustomed to the pasture of affected districts, suffer much less than others, and, only, after a long time. Cows and sluts, exposed to the poison during lactation, generally escape, while their offspring die. While grazing and browsing animals only are affected by the original cause, their flesh will reproduce it in all animals; and when the flesh is rejected immediately after being swallowed, the attack is not so bad.

The strongest argument, however, for the vegetable origin of the virus producing the disease, is the known fact, that *carnivorous* animals have the disease only after preying upon the carcasses of graminivorous and herbivorous animals that have died of the complaint.

Mortality, prognosis, &c. — The mortality is variously stated. Dr. Banks lost 3 out of every 6 cases; Graaf 5 out of 6; and Hilbert's mortality was only 5 per cent. Austin, another writer, lost 2 out of every 13.

After death the spleen is found dark and congested, the brain softened, and the blood uncoagulated.

When the disease is overcome by proper remedial agents, the heart and large arteries begin to return to their natural pulsations. The irritability of the stomach subsides, and the vermicular motions of the intestines can be perceived; the skin and extremities take on their natural heat, and, after a thorough purgation, the patient generally recovers speedily.

Tendency to coma after vomiting is a very fatal sign.

Treatment. — The prominent indications in the treatment of milk-sickness, are to allay gastric irritation, to relieve the affected organs, to remove constipation, and, lastly, to counteract the debility and exhaustion of the latter stages.

The utility of venesection has been disputed. As the disease, however, appears to be a modified form of cerebro-spinal meningitis, the only difference being the less strongly marked cerebral manifestations

and the more diffluent blood, much benefit might be expected from cautious topical bleeding.

Emetics generally do harm; while purgatives are necessary throughthe entire course of the disease.

The burning sensation at the præcordium may be allayed by the administration of alkalies; such as the ordinary soda powders, with half the usual quantity of acid.

Calomel may be administered with a view to its sedative effect upon the gastric mucous membrane, as well as its cathartic action. It should be repeated, in large doses, every four or six hours, until the bowels are evacuated; and, in cases of extreme irritability, it may be combined with opium. Stimulating injections are often serviceable in promoting the action of the bowels. When the stomach will bear it, a full dose of castor oil, combined with spirits of turpentine, will act beneficially after calomel.

Sinapisms and blisters should be applied early in the disease, if we wish any benefit from them.

In some instances, when the constipation of the bowels is overcome, and the vomiting ceases, there is a strong tendency to a typhoid state, requiring the free use of tonics and stimulants. Where the exhaustion is great, spirits, brandy, whiskey, or hot toddy, should be freely administered. In both the acute and chronic forms of this disease, alcoholic liquors can be taken in large quantities, without producing any intoxicating effects, and are, indeed, of much importance as remedial agents.

In his experiments, Graaf found that a strong infusion of galls had the effect of neutralizing the poison. Hence, much good might be expected from the judicious use of this and other analogous astringents.

YELLOW FEVER.

Syn.—Typhus Icterodes.—Bulam Fever.—Vomito negro.—Vomito prieto.

This is a disease of warm climates, depending upon a special cause, occurring mostly during the summer months, and ceasing on the appearance of frost. It is met with chiefly in towns upon the seaboard, or upon streams emptying into the ocean.

Symptoms.—The attack may or may not be preceded by prodromic symptoms, very often coming on without any warning, and occurring in the midst of ordinary health. It is generally ushered in with a chill, and severe pains in the back and limbs. After febrile reaction has been established, the skin is hot and dry, the respiration hurried, the face flushed, the eyes red and watery, and the conjunctiva much injected. There is a sense of uneasiness, sometimes tenderness at the epigastrium, accompanied by nausea and vomiting. The tongue is at first moist and covered with a yellowish-white fur; there is also extreme thirst. The pulse ranges from the natural standard to 120

or even 140. Sometimes it is unnaturally slow; either extreme is significant of great danger. Sometimes there are delirium and prostration; at others, the mind is clear, and the muscular strength unimpaired. The bowels are ordinarily costive, and when the discharges are obtained, they are commonly unhealthy in character. As the disease advances the pain in the limbs becomes more intense, especially in the lower extremities, the calves and front of the legs. This stage is called by some authors *the stage of invasion*, and lasts from a few hours to three days; the shorter the duration, the more violent, generally, is the disease.

After this comes the stage of remission, or, as it is sometimes called, *stage without fever*. All the symptoms abate, and the patient seems to be convalescent; there are symptoms present, however, by which the experienced are warned of the continuance of the disease. It is not the same as the remission of bilious fever, but is produced by the exhaustion of the powers of the system. The epigastrium is even more tender upon pressure, the skin becomes yellow or orange colour, the urine assumes a yellow tinge, and the pulse sometimes sinks as low as forty in the minute. After a short calm the stomach assumes its former irritability, and the peculiar substance called *black vomit* is ejected. The tongue is dry, brown, and chapped. The patient becomes more and more prostrated; there are, at times, passive hemorrhages, at others, suppression of urine, or retention. The pulse becomes more and more feeble, the respiration sighing, the matter ejected from the stomach is brought up without effort, and discharges of the same matter take place from the bowels. This stage is sometimes called *the stage of collapse*. Sometimes, instead of collapse, symptoms of reaction set in, which are always to be regarded as a salutary effort of nature, sometimes terminating in health, sometimes, however, running on to extreme exhaustion, or assuming a typhoid form.

Anatomical characters. — The membranes of the brain are often found injected, and serum effused into the ventricles. The stomach usually presents traces of inflammation, having its mucous coat either reddened, thickened, softened, or eroded. The peculiar matter called black vomit, is now generally believed to be blood altered by admixture with the acid secretion of the stomach. The liver is altered in colour and consistence. According to Dr. J. Hastings, late of the U. S. N., it resembles old boxwood in colour, and is much harder than natural. Sometimes it is dry and anæmic, though rarely inflamed. It varies in colour from a lemon-yellow to a straw colour, and in consistence, from being soft and friable to positive induration. It often presents evidence of fatty degeneration.

Cause. — Speculation is rife as to the cause of this disease. There is no doubt that it is as specific as that of small pox, though of its precise nature nothing definite is known. Heat and filth, alone, are not able to produce it; neither are marsh miasmata, independently of

other causes. The idea that it is owing to the same cause as that which produces remittent fever, is erroneous; for in many parts of the world where the latter disease is constantly occurring, yellow fever has never been known; again, yellow fever especially prevails in large towns, this is not the case with remittent fever. Acclimated persons are very seldom attacked with yellow fever, while it is well known that one attack of bilious fever secures no exemption from another. Nor are the symptoms of the two diseases alike: the first stage of yellow fever is *continuous* for one, two, or three days, while bilious fever remits from the first.

It may be that a peculiar *animal* miasm is generated under the peculiar circumstances which are connected with the origin of yellow fever; or possibly it may be caused by *organic germs* which, lodging in localities peculiarly adapted to their development, grow and rapidly spread themselves. Epidemic influences materially aid in disseminating it, though they never actually originate it.

As regards its *contagiousness* the weight of evidence and authority is divided. Dixon believes it to be contagious and portable. Others deny it altogether. Strangers are more liable to it than long residents, and whites more than negroes. Among the predisposing causes are exposure, intemperance, fear, and sudden changes of weather.

Diagnosis.—At first it is not easy. As the disease advances, however, the severe pains in the back and lower extremities, the peculiar injection of the conjunctiva, the excessive irritability of stomach, the yellowness of the skin, and finally the black vomit, are enough to diagnosticate the disease.

Prognosis.—Generally regarded as unfavourable, though much depends upon the person attacked, the character of the epidemic, and the severity of the symptoms. Symptoms of great prostration are very unfavourable, and a total suppression of urine is a certainly fatal sign. Strangury, however, is regarded as a favourable sign.

Treatment.—Early in the disease, before there is much irritability of stomach, an emetic is of great service, particularly if the stomach be loaded; it should only be used, however, under these circumstances. Bloodletting, to be of service, should be employed early, and even then, not unless called for by the violence of the symptoms and the state of the pulse. Cold affusion is highly recommended. Mercurials are, on all sides, declared to be of great service in this disease. They should be administered first with a view to their cathartic action, and then to their specific influence, as rapidly as possible. Febrifuge medicines are also called for; of these perhaps none is so good as ice given internally, together with cool sponging externally; the latter with caution. Ice also often allays the excessive irritability of the stomach. To the same end the effervescing draught may be employed, and sinapisms or leeches externally. If the pain in the head is very great, cups or leeches may be employed, together with cold applications to the part. In the *second stage*, the febrifuge and depleting

remedies should be suspended, except the mercurials, to which may be added the acetate of lead, with a view of diminishing the inflammation of the stomach, and also for its astringent properties. Blisters may also be applied to the epigastrium, and the raw surface sprinkled with acetate of morphia.

The muriated tincture of iron is highly recommended, in doses of 20 to 60 drops, every two hours. Its administration should be commenced before black vomit appears. Acetate of lead has also been found useful, given early.

In the *third stage*, cordials and stimulants are demanded. Sulphate of quinia, infusions of bark, or serpentaria, carb. of ammonia, capsicum, turpentine, wine whey, or brandy and water, may be administered. External stimulants, as frictions, sinapisms, hot baths, &c., may also be found beneficial. The apartment should be kept well ventilated, and all excrementitious matters removed.

TYPHOID FEVER.

Syn.—Common continued fever. — Enteric fever. — Typhus mitior. — Nervous fever. — Abdominal typhus. — Mucous fever. — Entero-mesenteric fever. — Follicular enteritis. — Dothinenteritis.

The term *Typhoid*, as applied to this disease, is regarded by some as objectionable, as it expresses only a condition common to many other disorders.

Symptoms, course, &c.—The disease is sometimes preceded by prodromic symptoms. There is a sense of weariness, languor, and general uneasiness, slight headache on rising in the morning, dulness of intellect, irregular flushes of heat, or chilliness, slight acceleration of pulse, furred tongue, and a disposition to diarrhœa. These symptoms may last from several days to a week or more, after which the disease is established by the occurrence of a chill followed by the ordinary phenomena of fever.

The disease being fairly established, there is increased frequency of pulse, ranging from 90 to 110 or 120; the latter usually in females; as a general rule, the pulse is under a hundred. There is headache, with a dull, heavy expression; pain in the back and limbs; restlessness and insomnia; epistaxis, and yellow watery diarrhœa.

As the disease advances these symptoms become aggravated, the pulse is more frequent and strong; the skin hot and dry; the tongue dries and becomes red at the tip and edges: there is pain in the right iliac region, with a gurgling sound upon pressure; tympanitis is also present, and there also appears about this time symptoms either of bronchitis or pneumonia.

About the seventh or ninth day, if the surface of the abdomen be examined carefully, there will be discovered upon it a number of small, round, red spots, disappearing upon pressure; these are called the *rose-coloured spots*, or *taches rouges*, and constitute a characteristic

eruption. They are about one line in diameter, and are slightly elevated. At the same time, or sometimes not until a week later, a crop of vesicles will also be detected upon the neck and thorax, called *sudamina*.

All the symptoms at this period are aggravated, delirium supervenes, with ringing or buzzing sounds in the ears, followed by dulness of hearing or deafness. The eyes are injected, the tongue becomes incrusted with a black coating, which often cracks and peels off, leaving the raw surface exposed, and the teeth are covered with sordes. The pulse becomes more feeble and frequent, there is a low muttering delirium, and sometimes twitching or spasm of the muscles. As the patient becomes more feeble he slips down to the foot of the bed;—there are involuntary evacuations, hæmorrhage from the bowels or other mucous surfaces, with petechiæ and vibices upon the skin, with great liability of the skin to slough. This is the usual course of the disease when it terminates unfavourably. If the disease is to terminate favourably, the symptoms abate, the countenance brightens, the tongue cleans, the pulse lessens in frequency, and the evacuations become more healthy. If the tongue ceases to clean, and if it again becomes dry, it indicates an increase of intestinal disease. It often happens that at this time the emaciation becomes more evident than it was before.

Sometimes, in the course of the second week, the patient is seized with intense pains in the abdomen, vomiting of green, bilious matters, a small fluttering pulse, syncope, constipation, and coldness of the extremities. The cause of these symptoms is perforation of the intestine, and escape of its contents into the cavity of the peritoneum, producing inflammation. It occurs most frequently in the mild forms of the disease, and is almost uniformly fatal.

Anatomical characters. — There is scarcely an organ of the body that may not be the seat of some anatomical lesion. Those which are considered characteristic of this fever, however, are thickening, softening, and ulceration of the glands of Peyer; the condition varying with the stage of the disease. Enlargement, softening, and ulceration of the mesenteric ganglia, more especially those corresponding with the morbid patches in the intestine, and, according to some writers, ulceration of the solitary mucous follicles of the ileum. These ulcerated patches are not due to previous inflammation, but to the deposit of a peculiar dark matter from the blood, named *typhous* or *typhoid matter*, beneath the mucous membrane, so as to elevate the patches of Peyer above the surrounding surface. The tendency of this matter is to soften; this causes the mucous coat to give way.

Other lesions met with are ulceration of the pharynx and epiglottic cartilage, softening of the spleen, sometimes of the liver and kidneys, hepatisation of the lungs, softening of the heart, and sometimes inflammation of the meninges of the brain with effusion. The blood drawn

in this disease is generally deficient in fibrine, and is said by some authors to contain an excess of blood-corpuscles; this is doubtful.

Cause.—On this point little is definitely known. It attacks all classes, rich and poor, though it is often generated where a number of persons are crowded together, with unwholesome, or insufficient food, and confined and vitiated air. It cannot be said to be contagious, since it is very seldom if ever communicated in isolated cases.

Age is a predisposing cause. It rarely attacks those beyond thirty. Strangers are more liable than long residents, and males than females. It may occur at any season, but most commonly in the autumn and winter. It rarely occurs more than once; hence, perhaps, its comparative infrequency in the aged.

Diagnosis. — By the slowness and insidiousness of the attack; by the diarrhœa; the dusky hue of the countenance; the epistaxis; the gurgling in the right iliac fossa; the tympanitis; the rose-coloured eruption; the stupor and delirium; the appearance of the tongue; and lastly, by the duration of the disease, and the peculiar musty smell when the skin is dry, and acid smell when it is moist.

Prognosis.—Not even the mildest cases can be looked upon as free from danger, and on the other hand there is no condition so low, no symptom so fatal, that death should be considered inevitable. Among the unfavourable symptoms, are constant delirium, a belief on the part of the patient that nothing ails him, a sudden shifting of position on the elbows, deep coma, stertorous respiration, great subsultus, rigidity of the limbs, profuse diarrhœa, or hemorrhage from the bowels, great prostration and frequency of the pulse, and excessive tympanitis. The favorable symptoms have been already mentioned.

Treatment. — This should usually be commenced by some mild laxative, such as a small dose of sulphate of magnesia, castor oil, rhubarb and magnesia, or a seidlitz powder, according to the nature of the case. The practitioner should always bear in mind the diarrhœa, or the tendency to it, and avoid all irritating and drastic cathartics. The next thing is to obviate febrile symptoms. This may be done by venesection, when the pulse is full and strong, and there is sanguineous determination to the brain, though as a general rule, it had better be omitted; it cannot arrest the disease. The protracted duration of the disease, must also here be borne in mind, and no blood drawn unless imperatively demanded. Leeches, or cups to the head, and to the right iliac fossa, may be advantageously employed, where there are evidences of congestion in the first, or of inflammation, as evinced by pain and tenderness, in the second locality.

Diaphoretics are useful throughout the whole course of the disease.

Of these, the neutral mixture, with tartarized antimony, or sweet spirits of nitre, may be given in the early stages of the disease, and the spirits mindereri with nitre, in the latter stages. Cold sponging, if it do not chill the patient, is an important remedy, and the internal

use of ice is often very grateful. If the patient be very feeble, spirits and water may be substituted for pure water.

Cold applications to the head, by means of ice in a bladder, are very serviceable in relieving the pain and delirium. The hair should also be taken off; and if the head be cold, while delirium is present, Chomel recommends the application of warm poultices. Should there be much abdominal tenderness, a few ounces of blood should be taken by leeches, followed by the application of warm fomentations. If the diarrhœa be profuse, it should be checked by opium, either alone or in combination with ipecac., or some astringent. Nervous symptoms may be combatted by the use of Hoffman's anodyne, camphor-water, or opium, if not contra-indicated.

In the advanced stage of the disease, when the tongue is dry, the urine scanty, and the skin parched, and there is delirium, or increased stupor, with an abatement of the vital actions, no remedy is so effectual as mercury, given so as slightly to affect the gums. Either blue mass or calomel may be used.

Should the disease not yield, especially if the tongue remain dry, and the abdominal distension undiminished, Dr. Wood strongly recommends the oil of turpentine, particularly in that stage of the disease when the tongue, instead of cleaning gradually from the edges and tip, parts rapidly with its fur, first from the middle or back part of its surface, which is left smooth and glossy, as if deprived of its papillæ. It should be given in doses of from five to twenty drops every hour or two, and its use continued for two or three days.

If the debility increase, the patient's strength should be supported by cordials and stimulants. Beef tea, or beef essence, wine whey, milk punch, together with the use of quinine, opium, serpentaria, &c., as the exigencies of the case may demand. Sloughing must be prevented by obviating pressure. Profuse epistaxis by plugging the nostrils. And in case of perforation of the intestine recourse must be had to large doses of opium.

Some practitioners use quinine throughout the disease. Others rely upon bleeding, "*coup sur coup*" (Bouillaud). Others upon purging throughout (Delarocque). Professor Mitchell has great confidence in the internal use of nitrate of silver, given in doses from $\frac{1}{3}$ to $\frac{1}{4}$ of a grain, and increasing it till a metallic film appears upon the fæcal evacuations. He speaks confidently of its controlling influence upon the diarrhœa and the nervous symptoms. By some it is supposed to act by coming in contact with the ulcerated plates of Peyer, upon which it exercises its specific astringent and sedative influence. Alum has been recommended for the same purpose.

The diet should be mild and unirritating in the early periods of the disease, gradually becoming more nutritious as the disease advances, and the debility increases. During convalescence it is of extreme importance to guard against an improper diet and fatigue. The debilitated condition, which is apt to remain, is best treated with quinine.

TYPHUS FEVER.

Syn.—Typhus gravior—Spotted fever.—Jail, Camp, and Ship fever.—Petechial fever.—Putrid fever.

As the terms *typhus*, *typhous*, and *typhoid* are frequently employed rather vaguely, they require explanation.

The word *typhus* is applied to a specific febrile disease, although the English writers generally do not distinguish between this and the proper *enteric* or *typhoid fever*. The t rms *typhous* and *typhoid* signify "a resemblance to typhus fever;" they are applied to other disorders which have assumed a *low* condition; thus we speak of *typhous dysentery*, *typhous pneumonia*, &c.

Symptoms.—Before the attack, the patient often exhibits certain premonitory symptoms. He is low-spirited and languid; loses his appetite, and he feels ill without knowing why. There are usually at the same time sharp pains in the head, back, loins, and lower extremities. Violent shivering is often the immediate precursor of the disease; sometimes, however, the cold stage is so slight as scarcely to be noticed.

The febrile condition, when fairly established, is generally well marked. The skin is hot and dry, and of the heat of that pungent, biting character called *calor mordax*. The pulse is full, frequent, and possessed of some degree of strength, but is easily compressed. The tongue is moist, and covered with a yellowish-white fur. Sometimes there is nausea and vomiting. The bowels are costive, and no stools are procured without medicine. The aspect of the patient is peculiar; the countenance is of a dusky hue, with injection of the eyes; the features are fixed and inexpressive, or expressive only of apathy and indifference.

As the disease advances the symptoms augment in violence; the heat of skin increases, the pulse rises in frequency, and diminishes in force, ranging generally from 120 to 150, or 160. The respiration is frequent, and, according to Gerhard, feeble and imperfect at the back and lower part of the chest, which is also dull on percussion. At a period ranging from the fourth to the eighth day, a peculiar eruption appears upon the surface, not confined, however, to any particular locality. It varies in colour from a dusky reddish-brown to purple or black. It is not elevated above the surface, neither does it disappear upon pressure. It is *petechial* in character, and is frequently accompanied with sudamina. The tongue becomes dry, brown, and cracked, and, along with the gums, is covered with sordes; the urine scanty and highly coloured; the dejections, when procured, black and offensive; a peculiar ammoniacal odour is exhaled from the body; the nervous symptoms become more prominent, there is dizziness, confused vision, tinnitus aurium, and sometimes deep stupor, which becomes characteristically more profound as the disease advances. Sometimes violent delirium (typhomania) takes the place of stupor; the patient is sleep-

less or restless, with the sensation of utter prostration and helplessness. Should no improvement take place the disease passes on to the last stage, that of prostration. The patient lies insensible, or in a muttering delirium, with subsultus tendinum, floccitation, hiccough, involuntary evacuations, and extreme insensibility of the surface, till at length death approaches silently and without violence.

Sometimes a critical discharge takes place from some organ, and the patient begins to convalesce, generally, however, by slow degrees, and under the influence of supporting remedies.

The duration of the disease varies, sometimes, in mild cases, terminating on the seventh day, sometimes running out to six weeks or more. Death rarely occurs before the second week.

Anatomical characters.—There is only one constant lesion (and it is questionable whether it can be considered entirely characteristic), viz., the want of coagulability in the blood, and the petechial eruption; all the other lesions may be considered incidental. No disease is discovered in the glands of Peyer, unless in some few cases, in which there is a complication with typhoid fever. A very fatal form of typhus fever prevailed among the black population of Philadelphia, in the fall of 1847. Many died at the onset of the disease. A number of post-mortem examinations were made, but the results were uniform in but few particulars. The blood was fluid and uncoagulated, resembling the settlings from claret wine. Petechiæ were not confined to the skin, but were numerous in the muscles and deep-seated cellular tissue. The skin, fasciæ, muscles, and cartilages, were often tinged with bile. There was great congestion of the liver, lungs, and brain. Thickening of the arachnoid, and effusion beneath it, were common appearances. Another common lesion was, an effusion of blood, in spots of variable size, between the under surface of the dura mater and the outer lamina, or parietal layer, of the arachnoid.

Andral mentions two cases of this kind, and considers them rare. In one it was the result of an injury, and in the other the result of chronic inflammation of the membranes of the brain.

Complications.—Pneumonia is most frequent in winter; and dysentery in summer.

Causes.—Crowding together a number of persons in badly-ventilated and filthy apartments; the persons so situated are capable of communicating the disease to others, although they may not have it themselves. Contagion is also a cause of this disease, though not a very powerful one where cleanliness and ventilation are duly attended to. Depressing influences of any kind are also capable of producing it. Sex has little influence upon it; it is more common after 35 than before this age, and it is rare in infancy. It prevails at all seasons, and in all climates, though perhaps more in winter, and in the temperate and cold climates.

Of the nature of the disease little is known. The probability is,

that a poison is absorbed which at once depresses the powers of the nervous system, and vitiates the blood.

Diagnosis. — The peculiar hue of the countenance, with suffusion of the eyes; the dark tongue, the sordes upon the teeth, the peculiar eruption, the constipation, the characteristic odour, and the collapse of the last stage, mark the disease. The differential diagnosis between it and typhoid fever, with which it is often confounded, is presented in a tabular form.

DIFFERENTIAL DIAGNOSIS.

TYPHOID FEVER.	TYPHUS FEVER.
Usually endemic; rarely epidemic.	Epidemic usually.
Not contagious.	Certainly contagious; may be communicated by those unaffected.
Young adults and children most liable.	Spares no age but infants.
Age of greatest liability under 25.	Age of greatest liability over 25.
Attacks strangers chiefly.	Attacks all residents.
Seldom ends before the 21st day.	Ends sometimes by critical discharges from the 7th to the 14th day.
Has no well-marked remissions.	Remission after the 3d, 7th, and 14th day generally, and after marked exacerbations.
Epistaxis common.	Epistaxis very rare.
Diarrhœa a frequent accompaniment; tympanitis.	Costive usually until the 2d or 3d week; abdomen flat.
Pulse usually under 100.	Pulse usually over 100.
Has a musty smell when the skin is dry; acid, when moist.	Ammoniacal odour, whether the skin is dry or not.
Characteristic eruption appears about the 7th or 8th day.	Eruption characteristic, appears earlier, and is more abundant.
Sudamina from the 10th to the 15th day.	Sudamina are rare in this disease.
Petechiæ are rare in this disease.	Petechiæ and vibices are common.
Has a constant anatomical lesion.	Has no constant lesion.
Has bronchitis commonly in the second week.	Pneumonia of posterior part of lungs more common.
No crisis by sweat, but a gradual recovery.	Crisis by sweating in nearly every recovery.
Occurs mostly in the fall and winter.	Occurs mostly in winter and spring.
Second attacks are rare.	Second attacks do occur.

Treatment. — A large well-aired room; frequent changes of linen, ablution of the patient's body; removal of all unnecessary carpets and curtains; and the instant removal of all evacuations, are measures desirable both to mitigate the patient's disease, and to prevent it from infecting his attendants. The chloride of lime may be scattered about the floor.

The treatment of fever, according to the best modern physicians, should be *expectant;* that is, the symptoms should be watched and relieved as they arise, but no violent efforts should be made to cut the disease short. In the first stage, if there is much nausea and gastric disturbance, a mild emetic of ipecacuanha may procure relief. The

bowels should be cleared out by an active aperient at the outset; say three grains of calomel, with rhubarb, and be kept open by milder doses; viz. hyd. c. cret., followed by castor oil, or an injection. *Mercury*, gently given, so as to touch the gums, has seemed of service in some epidemics, but not in others.

The hair should be removed; and the head be bathed with cold lotions so long as there is much headache, and so long as it is agreeable to the patient. If there is *great general heat* of skin, the whole body may be sponged with tepid water.

Bloodletting should never be practised from mere routine, but be reserved to combat any local inflammation that may arise. If the headache is very intense, with great heat, flushed face, and wild delirium, a *small* bleeding in the erect posture; or rather a few leeches, or the loss of a little blood by cupping from the neck, will be advisable. Profound coma should be treated by a large blister to the shaven scalp.

Great dyspnœa, with other signs of inflammation in the chest, must be combatted by a cautious cupping, followed by a blister, or mustard poultice; and small doses of senega.

If the type of the fever be very *low*, and there is great feebleness, it will be necessary to give good beef tea, and small quantities of wine from an early period; but this need not hinder the application of leeches to combat any local congestion.

The use of *opium* in fever is nearly the same as that of wine. The general rule is to give opium, where nervous excitement exceeds vascular action, where there is much delirium, and sleeplessness, with a feeble pulse. In some cases it is right to give a good dose at once; in others, to feel the way cautiously with small doses. In some cases of excitement, in young subjects, opium may be given in small doses, gr. $\frac{1}{4}$, with tartar emetic, gr. $\frac{1}{8}$. (*Vide* Graves' Clinical Medicine.) Opium and wine may be known to do good in fever, if they make the skin and tongue moist, the pulse fuller and slower, and if they allay nervous excitement, and produce sleep.

The state of the bladder should be inquired into every day; and the bed be kept dry and clean. Any spots that seem likely to ulcerate, should be washed with brandy, and protected with soap-plaster.

To conclude: the chief indications in the treatment of typhus and typhoid fever are, to nurse the patient carefully through it; to allay excitement; to prevent local inflammation; and to support the strength.

RELAPSING FEVER.

This is a disease arising from a specific cause, and characterized by a periodical succession of febrile attacks, alternating with apparently complete convalescence.

Symptoms, Course, &c.—The attack is generally sudden. The patient, previously in health, is seized, on waking in the morning, or

while engaged in his daily avocations, with rigors, more or less severe in character. The sense of chilliness soon begins to alternate with flushings of heat; the warmth of skin rapidly increases, and after a longer or shorter interval, the rising fever is accompanied with severe frontal and occipital headache, pain in the back and limbs, and frequent pulse. The tongue is dry, and slightly covered with a milky-looking fur; the bowels are constipated, though occasionally diarrhœa is one of the first symptoms; the urine is high-coloured; the appetite lost, and there is considerable thirst. The respiration is fuller, stronger, and more frequent than usual; the countenance is depressed, sometimes anxious, and the sleep either disturbed, or entirely gone.

With the advance of the fever, the symptoms become aggravated. The skin is dry and hot; the pains in the back and limbs increase in intensity, and the patient now complains of severe, muscular soreness, so severe, indeed, that he resists all attempts to change his position, lest the pain be augmented. The tongue is coated down its middle with a brown fur, while the tip and edges are parched and red. The heat of skin increases until it reaches as high as 100°, and even 107° of Fahrenheit's scale, indicating apparently great inflammatory violence. The heart, by the second or third day, often beats 100, 120, or even 130 strokes in the minute; and what is highly characteristic of the disease, the pulse gradually rises in frequency to 100, 120, 130, 140, 150, and, according to one observer,[1] 156 in the minute, in adults. The urine becomes scanty and is often voided with difficulty, and the thirst is urgent. Anorexia, nausea, and vomiting of green bile, are among the earliest symptoms. Tenderness at the epigastric region is a constant accompaniment of the disease, and very frequently pressure over the spleen gives evidence of pain and tenderness in that organ.

In the evening a slight exacerbation, succeeded towards morning by the usual remissson, is perceptible.

After a period, varying from five to ten days, an unusually severe exacerbation ensues, followed almost immediately by a profuse perspiration, which lasts from 12 to 36 hours. An entire solution of the fever takes place, and the patient in a few hours thinks himself perfectly well. The alteration is most remarkable: in the morning, the pulse may have been 130 in the minute, the skin hot and dry, the head throbbing; in the afternoon, the pulse is 60, the skin cool, the head free from pain.

On the following day, the patient is apparently, in every respect, free from ailment. His appetite returns, his strength improves, and we suppose him progressing favourably; when, at a period varying from the 12th day to the 20th, reckoning from the outset of the illness, or, on about the 7th, counting from the crisis, the patient is again suddenly seized with rigors, vomiting of green fluid and head-

[1] Dr D. Smith, Edinburgh Med. and Surg. Journal, for January, 1844.

ache, quickly followed by hot skin, rapid pulse, furred tongue, loss of appetite, and confined bowels; delirium perhaps supervenes, and, in fact, he is in the same state as on the day his illness commenced. The pulse, which falls remarkably during the period of apparent convalescence, often beating, the day preceding the relapse, as infrequently as 48 strokes in the minute, rises suddenly to 120, or even higher. After the expiration of two, three, four, or five days, the patient is again bathed in perspiration, and the next day is convalescent.

The great exacerbation and copious diaphoresis, generally occur, in the first paroxysm, on the fifth day; sometimes on the seventh, and in a very few cases on the ninth day.

The second paroxysm of this disease, though of shorter duration than the first, is characterized by the greater severity of its symptoms; and is, moreover, accompanied either by diarrhœa, or dysentery of a severe and troublesome nature.

Sometimes the patient suffers a third such attack, and even a fourth, fifth, sixth, and seventh have been observed. This protraction of the disease is, however, of very rare occurrence. The third paroxysm generally proves fatal.

Complications.—The most common complication is gastric irritation. This symptom, in some instances, amounts to little more than nausea, retching or slight vomiting, with occasional tenderness in the epigastrium; but at other times, the nausea and vomiting are excessive and constant, continuing for several days, when either medicine or drink is swallowed; and pressure over the stomach is intolerable. At first, the egesta are merely the fluids taken to allay the thirst; but as the vomiting continues, bile and even blood may be detected; and finally, black-vomit.

Another complication, and one peculiar to this fever, is jaundice. It generally makes its appearance about the third or fourth day; sometimes reaching its fullest point in a few hours, and at other times advancing gradually. It lasts from one day to a couple of weeks, and does not seem to interfere with the progress of the fever. However produced, it is certainly not dependent upon any obstruction or congestion of the biliary apparatus, inasmuch as the stools, during its continuance, retain their natural hue, or are darker than common; at the same time the urine is frequently loaded with bile. Moreover, post-mortem examinations show that the ductus communis allows bile to pass freely into the duodenum; even in those cases in which jaundice was present at the time of death.

Catarrhal symptoms are common during the winter, and among children. Pneumonia and pleurisy occasionally accompany the relapse.

Petechiæ are now and then present; and an eruption is sometimes seen resembling flea-bites somewhat, but differing from them and from

the tache rouge of typhoid fever, by being flatter and disappearing more readily under pressure.

Comatose symptoms sometimes supervene in old people, in whom there is suppression of the urine.

More or less violent delirium is now and then observed, after the critical discharge.

Anatomical characters.—No anatomical character of this disease has been pointed out. The most constant lesion by far is enlargement of the spleen. In the substance of this organ are found pale yellowish-pink masses of variable size, firm to the touch, but friable, with a slight granular fracture. A slight excess of serosity is occasionally found beneath the arachnoid membrane of the brain, and in the lateral ventricles. The blood, which, in a few cases, has been found fluid throughout the body, is generally buffy from the beginning. The liver is generally large, and the gall-bladder contains a considerable quantity of thick dark bile.

Cause, mortality, &c.—Of the cause of this fever little or nothing is positively known in the present state of our knowledge. It seems to be dependent on some specific poison, and according to the majority of observers, is contagious in its character.

The greatest mortality in any epidemic did not exceed 12 per cent. The ordinary mortality is from 3½ to 4 per cent.

A large majority of the pregnant women attacked by relapsing fever abort; and this accident is not unfrequently followed by death.

No particular day has been observed on which death from this fever takes place. When the fatal event was abour to occur, the patient seemed to sink into a state of lethargy or coma, from which they could be easily aroused, and would answer questions put to them with considerable correctness.

Diagnosis.—The rigors, vomiting, and pain in the back, might lead one to suppose the patient to be labouring under small-pox; but the pain in the back is rarely so severe, nor is the vomiting so incessant, as it ordinarily is in the early period of the last-named disease. The suddenness of the attack, the rigors, hot skin, pain in the limbs, and white tongue, distinguish relapsing fever from idiopathic head affections. The heat of skin, the quick pulse, the less violent headache, which is commonly frontal, serve to distinguish this fever from the ordinary bilious and remittent fevers. Neither the mulberry rash of typhus, nor the rose spots of typhoid fever, are ever present in relapsing fever.

Treatment.—Owing to the limited experience of the profession in this disease, much uncertainty exists as to its efficient treatment.

As it cannot be cut short, and as it naturally tends to a resolution about the fifth day, venesection is discountenanced by the majority of observers. If acute inflammatory complications exist, however, resort must be had to bloodletting, and the case treated on general antiphlogistic principles. Where the violence of the disease appears to fall

upon the spleen and the stomach, as is shown by the enlargement of the former, and the great irritation of the latter organ, cups over the splenic, and leeches to the epigastric regions, are highly serviceable, and should be repeated until the symptoms begin to abate.

During the chill, warmth to the skin,—either by sinapisms, friction, &c.,—is indicated to counteract visceral congestion, by giving activity to the cutaneous capillaries.

Diaphoretics judiciously exhibited, prove eminently useful in aiding the natural tendency to a crisis by sweating, and the temporary resolution of the fever.

Nothing is so useful in alleviating the great muscular pain and soreness of which the patient complains, as the hot infusion of Boneset,—the Eupatorium Perfoliatum of the U. S. Pharmacopœia.

To relieve the excessive pain in the head, resort may be had to cold applications, cups, leeches, &c. Sinapisms to the back will often serve materially in dissipating the intense lumbar pains which so greatly annoy the patient.

As the reproduction of the attack in this disease seems to depend, as in intermittent fever, upon the enlarged and congested spleen, the attempt should be made during the intermission, to relieve this organ and reduce its size by means of mercurials, iodide of potassium, quinia, &c.

The excessive debility, with which convalescence from this fever is generally attended, renders the early use of stimulants and tonics absolutely necessary to prevent the sinking of the powers of life.

VARIOLA, OR SMALL-POX.

This is a contagious disease, characterized by an initial fever of three or four days' duration, and followed by a peculiar eruption, which is at first papular, then vesicular, and ultimately pustular.

The disease was unknown to the ancients. It first appeared in Europe about the time of Mahomed.

Two varieties are commonly noticed—the *distinct* and the *confluent.* In the former, the pustules are completely isolated; in the latter, they run together, and are generally more abundant.

Three stages occur in the disease;—1, the initial or eruptive stage; 2, the maturative stage, commencing when the eruption is fully out; 3, the period of decline. Some consider the period which elapses between the inception of the poison and the attack of fever as a distinct stage of the disease, and enumerate the following stages: — 1st, Incubation, from six to twenty days; 2d, Invasion; 3d, Eruption; 4th, Maturation; 5th, Decline; 6th, Desquamation.

Symptoms.—The ordinary symptoms of fever, with increased pain in the back, and irritability of stomach, amounting often to obstinate vomiting; coryza and sore throat are frequently present; and in children, convulsions. The fever is of the remittent type, and subsides very decidedly on the appearance of the eruption, which, in the dis-

tinct variety, comes out usually in the course of the third day, — at first as minute red papules over the face, neck, chest, and abdomen, and finally over the lower extremities. It is generally completed in about two days. Now commences the *second stage*, when the eruption is fully out, and begins to undergo change, on the different parts of the body, in the order in which it first appeared. The pimples are converted into vesicles on the second or third day of the eruption, and become *umbilicated*, or depressed at the summit, on the fourth. From this time, they gradually increase in size, the lymph becoming opaque, until the vesicle has changed into a pustule. About the fifth day of the eruption, they lose their umbilicated appearance, and become convex and distended at the top, and about the *eighth* day of the eruption, or the eleventh or twelfth of the disease, they commence to turn of a brownish colour, sometimes to burst, and then dry up; and on the twentieth day, or thereabouts, the crusts fall off, leaving usually a permanent pit, or depression on the skin.

The *quantity* of the eruption varies from a few scattered pustules to a complete efflorescence over the whole body, the *isolated* character being, however, always maintained in the distinct variety. During the eruptive stage, the different mucous membranes become likewise affected, hence the pain in the throat, sore eyes, and coryza. The *skin* is apt to become swollen, especially on the face and head, during the filling and maturation of the pustules.

The *secondary fever*, or *fever of maturation*, comes on about the eighth or twelfth day of the disease, or the sixth or eighth day of the eruption: it depends on the sympathy of the constitution with the local affection, and is proportionally severe according to the intensity of the latter. During the period of maturation a peculiar greasy odour is given off from the patient's body, by which the disease may be recognised; violent itching also accompanies this stage.

The *third* or *declining stage* commences about the twelfth day of the disease. Some of the pustules dry up; others burst, pouring out their contents, which dry in the form of brownish scabs. This process of desiccation continues, and is generally completed by the fifteenth to the twentieth day, after which, circular brownish-red spots remain often for several weeks, together with the characteristic *pits*.

In *confluent variola*, all the symptoms are of a more grave type. The cerebral and gastric complications are more intense, there being persistent vomiting, and either delirium or convulsions. These affections may cause the death of the patient before the appearance of the eruption. The eruption, which is commonly *simultaneous*, and seldom *successive*, occurs about the *second* or *third day*, rarely on the fourth, and still more rarely on the fifth. It is sometimes accompanied by a rash resembling scarlatina or erysipelas.

The pustules are less prominent, and more aggregated, than in simple variola, and their edges run into one another. They do not, however, fill so completely as in the distinct form, and are flatter and

darker in colour. They are more numerous on the face than other parts; and in fact, when crusts begin to form, the whole face is covered, as it were, with a mask. This incrustation falls off from about the fifteenth to the twentieth day. The fever never entirely subsides, as in the distinct form; it is much aggravated during the second or maturative stage, and although generally of the sthenic character, it sometimes assumes a low tendency, and the patient may die from extreme exhaustion. By some writers, the greater intensity of the secondary fever is considered as diagnostic of this variety. The eruption usually begins to scab upon the face, about the tenth day of the disease. The skin here is excessively swollen; matter oozes out beneath the crusts, and is mingled with a bloody and ichorous discharge. The mucous membranes suffer greatly, especially those of the throat, larynx, nose, and eyes.

Should the patient survive the second stage, and pass into the stage of decline, he is still exposed to danger from pseudo-membranous inflammation of the larynx and fauces, pneumonia, pleurisy, destructive ophthalmia, sloughing or ulceration of the cornea and subsequent permanent opacity of this structure, excessive suppuration, erysipelas, and gangrene. After desiccation unsightly scars and pits are usually left behind.

In the condition called *malignant small-pox*, there is either a complete prostration of the nervous power from the very first, so that the patient never reacts from the onset of the disease, or there is a depraved condition of the blood, giving rise to petechiæ and vibices, and accompanied with other evidences of a typhous state. Death generally occurs in such cases from the seventh to the ninth day of the disease.

It is during the secondary fever, which is very violent in the confluent small-pox, that most danger is to be apprehended. Out of 168 deaths, recorded by Dr. Gregory, 27 occurred on the eighth day of the eruption (eleventh day of the disease). Thirty-two died in the first week, 97 in the second, and 21 in the third. In the first week, death seems to be caused by an overwhelming malignancy of the poison, oppressing the brain, and causing coma; in the second week, from affections of the respiratory passages; and in the third, from debility.

Prognosis. — The distinct variety usually recovers under proper treatment; the confluent is extremely dangerous, and the malignant almost necessarily fatal.

Cause.—A specific contagion. All are liable to be attacked unless previously protected. Epidemic influences appear to give greater energy to the specific cause, but they cannot *originate* the cause.

Treatment. — Under the old stimulating and heating plan of treatment, small-pox was a very fatal disorder. At present, it is much more manageable under the *refrigerant* plan. The room should be large, cool, and well-ventilated. In mild cases, the only medicines

required are refrigerant diaphoretics, and an occasional laxative. In severer cases a saline or mercurial cathartic may be given at first, followed by the other measures above recommended. Occasional sponging with cool or tepid water, if the skin be very hot and dry. It is important to recollect that the disease cannot be cut short, hence the strength of the patient should be husbanded. Dover's powder may be given at night to combat the restlessness. *Bleeding* is never required, except to counteract some intercurrent inflammation; and, in such cases, local bleeding would be preferable. After the first stage, very little is required; perhaps the nervous symptoms may call for the use of Hoffman's anodyne, or sweet spirits of nitre.

In the confluent small-pox, the treatment is often not so simple; but requires to be varied to meet the symptoms that arise, just as in fever. Great restlessness, wakefulness, and delirium, about the eighth or ninth day, are generally benefitted by opiates. If the pulse is feeble, broths and wine are required; especially if the pustules do not fill out.

During the *secondary fever*, which generally sets in about the eleventh day of the disease, aperients, opiates, tonics, and nourishing diet should be given.

Great dyspnœa requires a blister to the chest.

The intolerable itching is best allayed by smearing the eruption with cold cream.

Various measures have been proposed, in order to prevent the *pitting* and disfigurement occasioned by this horrid disease. Pencilling the pustules with lunar caustic, and with tincture of iodine; opening each of them; covering the face and hands with an ointment composed of litharge and mercurial ointment; keeping the patient in perfect darkness, have each been recommended, but with very doubtful success. They should all be tried before the eruption becomes vesicular. Where extensive crusts are rubbed off, dusting with powdered cinchona has been found useful.

Prevention of Small-pox. — There are two methods — *inoculation* and *vaccination.* The first is very effectual, because it actually imparts the disease in a mild form; but it is not unattended with danger, especially from multiplying *centres of contagion.* The other method, termed vaccination, is now universally practised.

VACCINA, the *vaccine disease*, or *cow-pox*, is the name given to a disease attended with umbilicated vesicles, produced by inoculation, and protecting the human system from small-pox. To Dr. Jenner is due the credit of first bringing into practice this artificial mode of protecting the system. The disease was noticed first in the cow (whence its name), in which animal it appears in the form of small vesicles upon the teats. The matter taken from such vesicles is protective.

The idea at present entertained is, that this disease is variola, modified and rendered milder by passing through the system of the cow;

and confirmatory of this view is the experiment of inoculating the cow with variolous matter, and then employing some of the matter from the resulting pock;—it was found to be protective.

Symptoms, Course, &c. — A very slight inflammation at the point of puncture is seen, which soon, however, disappears. On the third day, a little red speck, slightly elevated, is noticed, which has become a vesicle by the end of the fourth day. On the fifth, it is slightly umbilicated, and contains a clear lymph. This gradually enlarges, and on the sixth day the areola is visible; this continues to enlarge until the tenth day, when the disease is at its height. Now the pock is about one-third of an inch in diameter, elevated, umbilicated, and exhibiting a minute scab upon the surface. The areola is usually two inches or more in diameter. The scab now gradually forms, the serous liquid is replaced by pus, and about the twenty-first day the scab separates, leaving a cicatrix of a peculiar appearance.

The constitutional symptoms, if they occur at all, appear about the eighth to the tenth day. Sometimes there is a little fever, and swelling of the axillary glands, and occasionally a slight eruption.

There is great difference in the susceptibility of persons to the vaccine disease, also, in the same person, at different times.

In relation to the degree of protection afforded by vaccination, it would appear, as the result of numerous experiments, that about *one-half* the vaccinated are liable to a modified form of small-pox, or varioloid, on exposure. Still, cases of varioloid, are so rarely fatal, that it may be considered as almost certainly protective, so far as danger is concerned. Some suppose that the protective influence gradually wears out from the system, and requires renewal. This idea is incorrect; for in that case, the susceptibility to varioloid ought gradually to increase, the longer the interval from the period of vaccination; whereas, the susceptibility really diminishes after the twenty-fifth year. The truth appears to be, that the original amount of protection afforded by vaccination, differs in different cases; and that there is the greatest susceptibility to varioloid between the ages of 15 and 25 years. Hence, *revaccination* should always be practised *within these years;* or, if not then, certainly at the commencement of any variolous epidemic.

VARIOLOID.

This name is applied to a modified form of small-pox, occurring in persons protected by the influence of vaccination. As already remarked, the complete protection of vaccination extends only to about one-half of those subjected to it.

There is no reason for regarding varioloid as a distinct disease. The proofs of its identity with small-pox, are the facts that it varies much in its intensity, that it is produced by the same cause — contagion; and that it is capable of producing genuine small-pox in the unprotected. In some cases, the fever alone exists; in others, only an

eruption, either papular or vesicular, and most commonly in part pustular, going on to the fourth or fifth day, and then drying up. Its progress is always shorter, by several days, than variola, and it is destitute of the characteristic odour of that disease.

The *treatment* is the same as for mild cases of variola.

VARICELLA, OR CHICKEN-POX.

This is a contagious eruptive fever,—the eruption being vesicular.

Symptoms. — Occasionally febrile symptoms may be present, but generally they are very slight, and continue from a few hours to two days, when they disappear on the occurrence of the eruption. This comes out in small red spots, which speedily become vesicular, and are often accompanied with itching. They attain maturity about the fifth day, having become puruloid. They then commence to desiccate, the crusts falling off on the ninth or tenth day. The pocks are usually few in number, and very seldom umbilicated.

The only known *cause* is a specific contagion. It sometimes occurs epidemically. One attack is protective against a second one.

The only disease with which it can be confounded is small-pox.

Treatment. — Often, nothing is required. The mildest antiphlogistic means are sufficient.

RUBEOLA (*Measles*).

This is a contagious fever, accompanied with a peculiar eruption.

Symptoms.—Those of an ordinary fever, with the addition of those of catarrh, such as redness and watery appearance of the eye, coryza, with frequent sneezing, hoarseness, and cough. There may also be some dyspnœa and tightness of the chest. The eruption makes its appearance on the *fourth* day, in the form of small circular spots, first on the face, and extending itself successively within a day or two, to the neck, chest, and limbs. In general, the small spots are succeeded by larger ones, and the final arrangement of the patches is usually in a *semicircular* or *crescentic* form. The red tint of the eruption assumes its greatest intensity on the face on the *fifth* day.

The fever does not subside on the appearance of the eruption; it may even be increased, as also may be the catarrhal symptoms. The eruption is slightly elevated above the skin, and is attended often with itching, when at its height. There may also be a few papulæ or vesicles interspersed along with the regular eruption.

When the eruption is fully developed, the frequency of the pulse, heat, thirst, redness of the eyes, and coryza disappear, or are much alleviated; the nausea and vomiting also subside. About the sixth day, the watchfulness disappears, the cough and dyspnœa being the only symptoms that remain. On the third or fourth day of the eruption, the spots become pale, and gradually assume a yellow tint; and when the redness has disappeared, the epidermis becomes detached in small furfuraceous scales.

In children with a delicate skin, the eruption sometimes appears on the third day; but in those with a thick, brown skin, it may not be developed before the fifth day.

In some cases there is no catarrh; the disease is then named *Rubeola sine Catarrho* or *French measles.* Again, there may be simply a fever with catarrh, but without the eruption. These forms of the disease are not certainly protective.

In measles, the mucous membranes are very apt to be affected; generally, the membrane of the trachea, bronchi, fauces, nostrils, and eyelids, is principally affected, but sometimes that of the stomach or bowels principally suffers, producing nausea, vomiting, or purging. At other times, the membranes of the brain are implicated, inducing convulsions, stupor, or coma. It usually gets well in uncomplicated cases.

The *prognosis* is unfavorable when the child is very young, when the eruption appears before the third day, or when it suddenly disappears. A leaden hue of the spots, petechiæ, or excessive dyspnœa, are also unfavourable signs. The prognosis is favorable when the gastro-pulmonary symptoms are slight, the progress of the disease is regular, and when the skin is moist after the appearance of the exanthema.

The *sequelæ* of rubeola are bronchitis, pneumonia, pleuritis, cacocolitis, diarrhœa, and ophthalmia. The chief danger arises from the complication with pneumonia.

Causes.—A specific contagion. It is said to be imparted by *inoculation.* Epidemic influences also operate in its production.

Treatment.—When the gastro-pulmonary symptoms are slight, the treatment merely consists in keeping the patient in a mild temperature, on spare diet, and giving gentle laxative and diaphoretic medicines. If the soreness of the throat be very troublesome, the inhalation of the vapour of warm water is useful.

As a general rule, all inflammations that precede, accompany, or follow rubeola, when severe, should be treated as though that exanthema was not present. Should pneumonia, or laryngitis, set in, the treatment according to the above rule should be on the general principles laid down for the removal or alleviation of these affections. If the eruption disappears suddenly, the treatment must depend upon the cause producing this effect. If it is induced by the sudden development or increase of an internal inflammation, the attention must necessarily be directed to the immediate subduing of the inflammatory action. If the recession depends on cold, the warm or vapour bath should be had recourse to. Diarrhœa frequently comes on during the convalescence, and if not too severe, is useful in checking a tendency to thoracic disease; should it, however, proceed too far, small doses of Dover's powder, and the occasional use of the warm bath, will be found useful. A common sequela of measles is, a short, hoarse, and barking cough, which has a great deal of the croupy sound, but is not

attended with dyspnœa. It readily yields to counter-irritants. During convalescence, exposure to cold should be guarded against. The *malignant* form is treated with stimulants both internal and external.

SCARLATINA.

This is a contagious, eruptive fever, particularly affecting the skin and mucous membrane of the throat. About the second day of the affection, the whole surface of the body presents little red points, which are soon followed by patches of a deep scarlet colour, serrated at their edges, which become confluent, and terminate by desquamation from the fifth to the ninth day. The rash is slightly elevated above the skin, and disappears on pressure.

Scarlatina occurs under three forms—*Scarlatina simplex*, *S. anginosa*, and *S. maligna.*

SCARLATINA SIMPLEX.

The precursory symptoms of this form are, general debility, nausea, shiverings, followed by flushes of heat and thirst. On the *second* day of the febrile symptoms, little points, at first of a light red, then becoming deeper, appear in great numbers on the face, neck, and chest. In the course of twenty-four hours, similar spots appear on the body, lips, tongue, palate, and pharynx. On the *third* day, most of the interstices which had been left are covered with large dotted patches, having serrated edges. In this stage the pulse is full and very frequent, the tongue is covered with a creamy coat, through which the red and elevated papillæ appear, producing a characteristic appearance of the organ. The skin is much hotter in this form of exanthema than in any other. The scarlet colour is of a deeper tint on the groins, buttocks, and folds of the joints, than in other situations.

About the *fifth* day, the interstices between the patches become larger, the scarlet colour less vivid, and slight desquamation takes place on the neck, temples, and chest. On the *sixth* day, the character of the disease becomes less distinct; and on the *eighth* and *ninth* days, desquamation from the surface of the hands, feet, and the different regions of the body, takes place.

SCARLATINA ANGINOSA.

Symptoms. — This form is characterized by the accompanying inflammation of the throat; it commences with more intense fever, and a sense of stiffness of the neck and inferior maxilla. On the *second* day, the pharynx is inflamed, deglutition is difficult, the amygdalæ become swollen, and the mucous membrane presents a vivid red appearance. In the S. simplex, the pharynx presents an exanthematous blush, but there is no effusion; in this form, however, a quantity of thick, viscid fluid, sometimes of a whitish-yellow colour, but more generally caseous-like matter, is thrown out on the amygdalæ, pharynx,

and anterior pillars of the velum. During the second, third, and fourth days, symptoms of gastro-enteritis are present; the tongue is of a bright red colour; there is nausea, vomiting, diarrhœa, or constipation, dry cough, quick and vibrating pulse, and occasionally epistaxis. The eruption, which appears on the *third* day, is not so generally or equally distributed as in the former affection. It also sometimes disappears suddenly, frequently on the day after its appearance, and returns again after an uncertain period of time. The entire duration of this form is longer than in simple scarlet fever, and its order of appearance, and that of its desquamation, are not so regular. It is much more dangerous.

SCARLATINA MALIGNA—MALIGNANT, OR PUTRID SORE THROAT.

Symptoms.—This form comes on like the scarlatina anginosa, except that the symptoms are of a graver type even on the first accession. Sometimes, in fact, the patient is stricken dead by the poison in a very few hours before any eruption or local symptoms come on. The throat affection is however usually very prominent. The eruption does not present a scarlet appearance, but is more of a livid hue, and frequently interspersed with petechiæ. It is irregular in its first appearance, and it may disappear and reappear several times. In this form of scarlatina the pulse is small and irregular, the teeth and tongue are covered with brown or black incrustations, the eyes are much injected, and the vision is confused; the respiration is laborious, and the breath is fœtid; the pharynx is covered with thick, viscid mucosity, and there is often sloughing of the surface of the amygdalæ. Convulsions and coma are frequent concomitants of this affection in children, while delirium and deafness attend this form in the adult.

The appearance of numerous petechiæ, of abundant diarrhœa, of difficult respiration, or of persistent coma, announce the approach of death.

The *sequelæ* of *scarlatina* are, anasarca, ophthalmia, otitis, bronchitis, enteritis, orchitis, and tonsilitis, in adults; abscesses of the submaxillary and parotid glands, &c., in children.

Treatment.—In *scarlatina simplex*, when the bowels are constipated, mild purges may be employed. Rest in bed, spare diet, cooling acidulous drinks, and, where the surface of the body is extremely hot and burning, cold sponging, are the means principally to be relied on. A mild emetic given at the onset, is thought to modify it.

In *scarlatina anginosa* and *maligna*, the treatment must be varied to meet the symptoms. If there is violent cerebral excitement, leeches or cups may be applied; but if the powers of life are low, it may be necessary to give wine, beef-tea, cinchona, &c., from the very commencement. The *throat* always requires great attention. The patient, if able, should use a gargle containing muriatic acid, or chloride of soda, and should inhale the steam of vinegar and water.

The best gargle is one made by infusing an ounce of red pepper in

a pint of boiling vinegar and water. In cases of young children, it may be applied by means of a swab. The bowels should be regularly cleared by mild aperients and enemata. The citrate of potassa, given in a state of effervescence, is an excellent medicine in most cases. Cool sponging is of service when the heat of the surface is steadily high, and anointing the whole surface with lard or some other unguent, has been found very useful in allaying heat and restlessness; but in malignant cases it is to stimulants that the practitioner has chiefly to look for the safety of his patient.

The internal and external use of chlorine throughout this disease is highly recommended by some authors. It may be used either in the form of the aq. chlorinii f ʒss, aquæ font. f ℥viij, and syrup. f ℥j; a tablespoonful of the mixture being given every hour or two, or it may be given in the form of a solution of chlorate of potassa, in the proportion of a drachm to a pint of water, and used *ad libitum*. It may also be used as a gargle to the throat. When pseudo-membranous or gangrenous patches are observed in the fauces, and the colour of the membrane is dark-red, an infusion of capsicum is an excellent application. The sulphate of zinc, or nitrate of silver, is also useful under similar circumstances. When the sloughs are offensive, the fœtor may be often corrected by a creasote gargle, or a gargle of pyroligneous acid in solution.

Fomentations and poultices may be applied to the throat; leeches are usually of no benefit.

Belladonna is sometimes used as a preventive. It may be given in a solution made by dissolving three grains of the extract in a fluid-ounce of distilled water, of which three drops is the dose for a child under one year, increasing it one drop for every year.

During convalescence, the patient should be protected from cold, and ought occasionally to employ tepid baths, and frictions to the surface.

ERYSIPELAS.

This is an exanthematous fever affecting the skin or the sub-cutaneous cellular tissue, or both. It arises from a peculiar poison, and is not contagious. It is sometimes merely a local disease depending upon some local injury.

There are two chief varieties of it:—the *simple*, which affects the skin, and ends in vesication and œdema; the *phlegmonous*, which affects the subcutaneous cellular tissue likewise, and causes unhealthy suppuration and sloughing.

SIMPLE ERYSIPELAS.

Erysipelas always begins with shivering, nausea, and other signs of fever, and derangement of the stomach. The skin of the part affected becomes slightly swollen, and of a red colour; there is acute pain, with a sensation of burning heat, but no throbbing, as in phlegmon. The

redness disappears on the slightest pressure, and reappears immediately on its removal. It is very apt to commence on the side of the nose, or ear, and it has a definite boundary. In some instances, small miliary vesicles appear, in others bullæ or phlyctenæ are observed. The most favourable termination is in resolution, in which case the epidermis is thrown off in small scales. It occasionally assumes an *erratic* form, and sometimes it terminates by *metastasis* to some of the internal organs.

Phlegmonous erysipelas.—In this form the redness is very vivid, and diminishes in intensity from the centre to the circumference. The cellular tissue being implicated in this affection, produces swelling, hardness, and a burning pain. This affection may terminate in resolution; but should it proceed to suppuration, and measures are not employed to allow of the exit of the pus, abscesses will form, and the cellular tissue between the muscles will become implicated. The abscesses and sinuses thus formed, will gradually burst externally, when a quantity of gangrenous masses, mixed with fœtid pus, will be discharged. The constitutional symptoms in this case indicate that much mischief is going on. The pulse becomes quick and hard, and the tongue brown; encephalitis, meningitis, or gastro-enteritis, may come on, and the patient sinks under diarrhœa, with low muttering delirium and coma.

Œdematous erysipelas.—This is the name given to *simple erysipelas* affecting loose cellular parts. The skin is smooth and shining; and pits on pressure. This affection often induces gangrene, the skin being deprived of its supply of blood through the distension of the cellular tissue; the accession of this is announced by acute pain, a red and shining skin, with sometimes a livid or leaden hue. The genitals in women, the scrotum in men, and the infiltrated limbs of hydropic patients, are the most usual seats of the œdematous erysipelas.

Erysipelas of the head and face is generally of the simple or œdematous variety; and is the form which the disease assumes, when there is no wounded part for it to fix upon. It is very dangerous, as the contiguous irritation is liable to cause inflammatory excitement, or effusion within the cranium.

Erysipelas is usually of a sthenic character; but in certain epidemic conditions, it may assume a malignant form. The disease termed *black tongue* is probably a malignant form of erysipelas, without an eruption.

Treatment.—When the surface of the inflamed part is of a deep or florid red, tense, and very hot; the pulse hard, full, or strong; the head much affected, general *bloodletting* may be requisite, especially in unbroken constitutions, in persons not addicted to drinking to excess, and very early in the disease. Leeches cannot be used, because the punctures may take on the erysipelatous inflammation.

At the outset, an *emetic* may often be administered with advan-

tage; and in the severer cases calomel together with the refrigerant diaphoretics.

After depletion, Dover's powder is useful at night. If the disease continue after the first week, it will be proper to use *mercury*, along with opium and ipecac., so as gently to affect the system.

In malignant and gangrenous cases, stimulants and tonics, especially Peruvian bark, are indicated.

Local treatment.—At first employ cold mucilages; and if disposed to extend itself, use tincture of iodine, or a strong solution of nitrate of silver, to circumscribe the disease.

When the functions of the different secerning and excerning glands have been properly restored, *tonics* and *alteratives* should be employed; of the former class, the preparations of cinchona are those most recommended.

In the *phlegmonous* form, *free incisions* should be employed early, before the matter burrows deep, and causes much constitutional irritation. Permanent and diffusible stimuli should be used, and if there is much restlessness, opium should be exhibited, unless there is a tendency to coma. Free incisions, followed by poultices, are the most efficient means in this case, as they tend not only to allow of the escape of matter, which acts as a foreign body in the system, but also to relieve the tension of the parts, and to destroy the inflammatory orgasm in them. Bleeding from the incisions should be carefully watched, as it is sometimes profuse; and it may, if uncontrolled, or unaccompanied by a sufficiently restorative treatment, especially in drunkards and those of broken-down constitutions, be attended by dangerous consequences. If the affection has been neglected until sloughing has occurred, before incisions have been made, lint dipped in oil of turpentine, or in equal parts of it and Peruvian balsam, should be applied, and covered by warm poultices.

RHEUMATISM.

By some pathologists this is considered only as common inflammation attacking the fibrous tissues, and deriving its peculiarities from the tissue involved. There is reason, however, to believe that it is peculiar in its character, and that any tissue of the body may be attacked.

Four varieties are noticed,—the acute, subacute, chronic, and nervous.

Acute Rheumatism.—This variety usually attacks the larger joints. There is considerable fever, either commencing with or soon following the local inflammation. Sometimes a single joint is at first affected, others following in succession; at other times, several joints are simultaneously involved. Other tissues may also be attacked, as the muscular, areolar, and dermoid. The fever is of the sthenic character. Pulse full and strong, the tongue thickly furred; excessive pain in the joints, much increased by the slightest pressure or motion. There

is also a copious acid perspiration. It is very apt to shift from one joint to another, and especially to fix upon the heart or pericardium, causing endocarditis and pericarditis, of which the occurrence of *delirium* is usually a significant warning. Occasionally the fever is adynamic. The blood when drawn exhibits decided increase of fibrin, which often amounts to ten parts in a thousand.

Causes. — The most frequent is exposure to cold and damp, after free perspiration, especially in persons constitutionally predisposed. It is rare before the eighth year of age, and seldom occurs in the aged. It is also hereditary.

Prognosis.—When properly treated, it usually gets well. The chief danger is from the complication of the heart disease; but this also generally yields to active treatment. In children under fourteen years, it is a dangerous affection.

Subacute Rheumatism. — This variety is very common; it occurs usually in the muscles, though it may also attack the joints, involving either the synovial membrane, or the surrounding ligaments. The pain is often severe; but there are much less fever and swelling than in the acute form. In muscles it causes pain in movements; in the mucous membrane of the bowels, it produces diarrhœa; in the bronchial tubes, catarrhal symptoms, &c.

It receives various names, — as *torticollis*, when it affects the muscles of the neck; *pleurodynia*, when it is seated in the muscles of respiration; *lumbago*, when in the muscles of the back; *sciatica*, when in the neurilemma of the sciatic nerve; *hemicrania*, when located in the scalp. When in the muscular coat of the bowels, it produces colicky symptoms. It is apt to seize upon the heart, where it is the source of great danger, and often causes sudden death, from its inability to contract. Probably many cases of supposed angina pectoris are referable to this cause. It is, moreover, a more common cause of organic disease of the heart, than the acute form. It also attacks the diaphragm and the uterus, — in the latter case, giving rise to dysmenorrhœa. It may last many months, and often resembles neuralgia.

Causes. — Similar to the acute, but dependent upon a difference in the constitution; there may be less plastic matter in the blood. It is dangerous only when it attacks some vital organ, as the brain or heart.

Chronic Rheumatism.—This form is most apt to fix upon the joints and synovial membranes. There is no fever nor heat, but little redness, and only an obscure dull pain, usually worse at night and in damp cold weather. The joints are apt to become permanently swollen and stiffened. It may last a lifetime, and is either the result of the acute form, or is produced by the same cause, only modified by the constitution.

Nervous Rheumatism is that form of the disease in which the sen-

sation or function is only affected, without inflammation; it is analogous to nervous gout.

Nature of Rheumatism. — It is not well understood. The inflammation is certainly *peculiar*, since it rarely or never suppurates, and it evinces a disposition to metastasis. Some ascribe it to an excess of acid.

Treatment. — In the *acute* variety, bleeding is well borne, but it cannot cure it. Be cautious about too much bleeding, lest there be set up a tendency to irritation in certain important organs, which thus become centres of attraction for the rheumatism. Active purging is always proper; it may have to be repeated in a few days, or the bowels be kept steadily open by sulphate of magnesia and thirty drops of wine of colchicum.

Refrigerant diaphoretics are indicated, and Dover's powder, in full dose, is to be given at bedtime.

If it does not yield by the second week, resort to *mercury*, which may properly be combined with opium. Colchicum and morphia should be used, if it is disposed to move about. If attended with adynamia (as indicated by perspiration during sleep), *quinia* is an admirable remedy in doses of twelve to twenty-four grains during the twenty-four hours. *Excessive* doses are dangerous, as causing a tendency to the brain.

Should it be complicated with cardiac affections, bleed generally and locally, blister, and commence the mercurial course *at once*. If the brain is involved, the treatment is the same. The adynamic form requires stimulants.

Lemon juice has been lately highly recommended. Other plans have been practised, as repeated bleedings, *coup sur coup;* very large doses of tartar emetic, or of nitre, excessive doses of opium, acetate of potassa in full doses, iodide of potassium, etc. Prof. J. K. Mitchell, who regards this as a disease of *spinal* origin, has had much success in the acute form by the application of cups to the spine, in the neighbourhood of the affected part.

As regards the *local treatment*, there is risk of repelling it from the joints to the internal organs, by the use of powerful remedies, as cold, &c. The part may be covered up in carded cotton or flannel, or a hop poultice, or mild anodyne liniment applied.

In the *subacute* form, local bleeding is often beneficial, as cups in lumbago or pleurodynia. The bowels should be kept free with Scudamore's mixture. Dover's powder, tincture of aconite root in doses of five drops every four hours, warm baths, and, if persistent, the constitutional impression of mercury should be employed. Local remedies must be used with caution, from the danger of repelling. Blisters are hazardous. Persons liable to this variety of the disease, should take at the onset a dose of Epsom salts, with morphia and colchicum.

In the *chronic* form, bleeding is rarely employed; cups and leeches

are often of use; moderate purging, and then laxatives, as sulphur, &c.; the hot bath (especially the sulphur springs), revulsion, Dover's powder at night, iodide of potassium, or iodine in other forms, extr. of belladonna, conium and stramonium, sarsaparilla, guaiacum, &c. A mild and continued course of mercury will often clear it out entirely. A long journey, or a sea-voyage, often proves decidedly beneficial. The chief *local* measures are, blisters, repeated, and other revulsives, frictions, and tincture of iodine.

GOUT.

A constitutional disease analogous to rheumatism, characterized by an excess of uric acid in the system, which is separated from the urine, and, occasionally, is deposited in the joints in the form of *chalk-stones* (urate of soda).

Three varieties are noticed;—the acute, chronic, and nervous.

Acute Gout occurs in persons of vigorous constitution, and in adults. It is occasionally preceded by some febrile symptoms, but usually the attack is sudden in the night, the patient being seized with an acute tearing pain, mostly in the ball of the great toe, together with some of the smaller joints of the feet.

The ordinary signs of inflammation are present, as heat, swelling, redness of a bright tint, and exquisite tenderness, together with turgescence of the neighbouring superficial veins. In about eight or ten hours these symptoms all abate except the swelling, which becomes œdematous. The fever usually remits with the decline of the other symptoms, but the paroxysm returns towards the next evening; and so it is apt to do for about a week, when it goes off with copious perspiration, lateritious urine, or diarrhœa. The cuticle of the inflamed part desquamates with excessive itching.

After the fit is over, the patient feels better in his health than he had done for some time before. But without great care, another fit comes after some months; and the disease becomes established in paroxysms, which almost every time recur at a less interval and more severely; till at last in some cases the disorder becomes *chronic* and *habitual*. The joints affected return to their usual pliability after the first few attacks, but gradually become stiff and crippled, and deposits of *lithate of soda* are formed in them.

Besides these evils, gouty persons are liable to various anomalous and dangerous affections of internal organs. Sometimes they are seized with pain of a cramp-like character in the stomach, with coldness and deadly sickness;—sometimes with extreme pain of the heart, palpitation, and dyspnœa;—sometimes with furious delirium and headache, or coma; and as these symptoms are relieved by the appearance of gout in the foot, it is evident that they arise from the gouty poison; and such attacks are often called *misplaced gout*. If such symptoms

come, upon the gout leaving the extremities, the case is said to be one of *retrocedent gout.*

Gouty people are also liable to inflammations of the eye, lungs, and other parts, which are very stubborn when treated with common remedies, but yield generally to colchicum.

In the *stomach*, gout may assume two opposite forms,—one, that of violent acute gastritis, the other that of spasm. In the *bowels*, it takes the form of colic or diarrhœa. In the *lungs*, it produces bronchial congestion or dyspnœa. In the *heart*, it produces excessive oppression, dyspnœa, and syncope. In the *kidneys*, violent nephritis.

Chronic Gout is generally the result of the acute. The attacks are frequent, but without fever; there is a purplish colour and œdematous appearance of the parts, from synovial effusions. It is disposed to wander from joint to joint.

Nervous Gout, called also *atonic* or *irregular* gout. This variety occurs in persons of hereditary gouty tendencies, but whose constitutions have been modified by a careful mode of living, hence its frequency in women and nervous men.

Many cases of supposed neuralgia are really cases of nervous gout. The pain may be dull or lancinating, fixed or fugitive, confined to a single part, as the head, or distributed over many parts. Often it displays itself in *disordered function*, as dyspepsia, dyspnœa, cough, palpitations of the heart, irregular pulse, dizziness, syncope, &c. It may prove fatal by a sudden retrocession to some vital organ, as the heart; or, by its frequency, inducing some organic disease.

Causes.—There is always a predisposition or diathesis, either inherited, or artificially created by luxurious living and indolent habits. In such persons, the slightest cause may bring on a paroxysm.

Nature.—Not well known. By some it is attributed to an excess of uric acid in the blood: but this will not explain *all* the phenomena. Indeed, this very excess of acid is itself the *result* of the gouty diathesis, rather than the cause.

Diagnosis.—It presents many resemblances to rheumatism, but differs in the following points:—1. Rheumatism affects chiefly the young or middle-aged; gout, the elderly. 2. Rheumatism prefers the larger joints; gout, the smaller, and especially the feet and hands. 3. Gout is attended with more obvious disorder of the digestive organs; the pain is of a more burning character, and the swelling greater and more vividly red.

Treatment during the paroxysm.—It is important to remember, that the disease is not merely local, and hence that it is dangerous to repel it by violent means. Commence with a brisk cathartic, as calomel or senna draught, followed by laxatives, if necessary. The great remedy is *colchicum*, which is to be exhibited as soon as the bowels are open, in doses of 20 or 30 drops of the wine, every four hours, either alone, or in combination with magnesia and Epsom salts. Blue mass and

bicarbonate of soda may be given at the same time, and a full dose of Dover's powder, at night, to relieve the pain.

As regards the *local* treatment, very little should be done. The part may be bathed with warm water, or wrapped up in flannel, or the mildest camphor liniment applied. Cold water is very dangerous. *Bleeding* should not be practised, except to relieve violent internal inflammation; and even in that case it is better to try to call it out to an external part by revulsives.

The *diet* should be low at first; though, in the intemperate, some latitude is to be allowed.

Treatment in the interval.—The chief indication here is to correct the habits of the patient, so as to remove the diathesis. The diet should be moderate, but not too abstemious; vigorous exercise, especially on horseback, should be enjoined. All the functions should be sedulously attended to; the bowels kept regular; acidity of stomach corrected, and the secretion of the liver preserved. A pill containing one grain of blue mass, one of acetous extract of colchicum, and three of the compound extract of colocynth, may be taken with advantage.

In chronic gout, attention should be directed to the digestive and secretory organs; acidity is to be corrected; iron is often of advantage, and also the iodide of potassium; but, especially, a long journey or voyage.

In nervous gout, the general rule is to give the disease an external direction, by revulsives. If intermittent, quinine, in large doses, is the proper remedy. Anodynes are often required, of which opium and aconite are the best. The tincture of the root of aconite, and chloroform, are excellent *external* applications.

For sudden attacks of gout in the stomach, heart, &c., the indications are to put the feet in hot mustard and water, to apply mustard poultices to the epigastrium, and to give some warm stimulant internally. These may be followed, as soon as the symptoms permit, by a dose of calomel and opium, succeeded by a laxative to remove the offending matter from the stomach and bowels.

CLASS II.

LOCAL DISEASES.

SECTION I.

DISEASES OF THE ORGANS OF DIGESTION.

STOMATITIS, OR INFLAMMATION OF THE MOUTH.

THIS may be of various kinds.

I. COMMON DIFFUSED INFLAMMATION

Occurs either in patches, or covering the whole surface. It is attended occasionally with submucous infiltration and enlargement of the uvula. When more especially confined to the fauces, it is termed *angina*. The *treatment* consists in a saline purge, and a gargle of sage tea and alum. When chronic, the astringent vegetable or mineral washes may be used.

II. FOLLICULAR INFLAMMATION

Consists in little enlarged prominences, scattered over the lining membrane, of the size of a small shot. They are enlarged mucous follicles, and are sometimes disposed to ulcerate. The disease is usually chronic. When between the palatine arches, it constitutes the "clergymen's sore throat." It sometimes extends far down the pharynx, running into ridges, and secreting a tough mucus. It is often kept up by low health; hence in treating it, remedies must be constitutional as well as local. The best local application is a strong solution of nitrate of silver, applied daily.

III. APHTHOUS, OR VESICULAR INFLAMMATION.

In this variety there are small whitish ulcers, either isolated or in patches. The ulcers are preceded by pearl-coloured vesicles. It attacks both children and adults, and extends down, occasionally, into the stomach. The *treatment* is chiefly local, and consists of the application of a strong solution of the sulphate of zinc (15 to 20 grs. to the ounce), or of sulphate of copper, or nitrate of silver.

IV. THRUSH, OR MUGUET.

An inflammation, accompanied by an exudation of a whitish curd-like matter, in patches, generally confined to young children, though sometimes occurring in adults, in the advanced stage of low diseases, as phthisis or dysentery. Infants badly nourished, especially artificially, are most exposed to it. At first, there is redness, then little whitish spots about the corners of the mouth and inside of the lips, which run together so as to form patches of a whitish or grayish

matter, which can be scraped off. The microscope shows it to consist of a cryptogamous plant. It is not contagious. It is, probably, a consequence of some constitutional derangement.

Treatment.—In good constitutions give a laxative, as magnesia or castor oil, and apply a mixture of equal parts of borax and loaf sugar. If obstinate, use the sulphate of zinc. Attend also to the diet, and fresh air. If there is diarrhœa, use test. ppt. and opium; if constipation, use magnesia; tonics and iron if debility is present.

V. PSEUDO-MEMBRANOUS INFLAMMATION.

This consists in a fibrinous exudation, usually of a whitish colour and firm consistence, though in depraved constitutions it may be dark. The surrounding inflammation is slightly elevated, so as to give the patches the appearance of ulcers. It is sometimes termed *diphtheritis.* There are also pain and swelling, together with fetor of the breath, causing it to be mistaken for gangrene. The constitutional symptoms are fever, diarrhœa, sometimes vomiting, and a sero-purulent discharge from the nose, as in scarlatina. It may be either of the sthenic or asthenic character.

Cause.—Some predisposition of system, or depravity of the blood. It is frequently epidemic.

Treatment.—In good constitutions, the antiphlogistic plan, without bleeding; *mercury* may be used if it is spreading into the larynx. In the low cases, a good diet and stimulants are requisite. The *local treatment* is very important; it consists of a solution of nitrate of silver, 20 to 60 grs. to the ounce, applied only to the affected parts.

VI. ULCERATIVE INFLAMMATION OF MOUTH.—CANCRUM ORIS.—CANKER.

Any inflammation of the mouth may result in ulceration. But this affection consists in an ulcer from the very commencement. It occurs on the gums, inside of cheeks, fauces, and lips. Sometimes the ulcer is deep and destructive, and is accompanied by an offensive breath. It generally occurs in children of a debilitated habit, though sometimes in those who are otherwise apparently healthy.

The *treatment* consists in a mercurial cathartic, followed by laxatives; and, in protracted cases, iodide of potassium, but especially the *local* application of a strong solution of sulphate of zinc, (twenty grains to an ounce of water), or sulphate of copper, or nitrate of silver.

VII. GANGRENOUS INFLAMMATION, OR GANGRÆNA ORIS.

A peculiar form of disease—gangrenous from the first. It occurs most frequently in the inside of the cheek and gums. It is very destructive to the tissues involved, often causing necrosis of the bones, great exhaustion, and frequently death. It usually attacks unhealthy children in miasmatic countries, also in infirmaries where numbers of children are crowded together, and not subjected to proper hygienic treatment.

Treatment. — Obviate the depressing cause by good diet, country air, tonics, quinine, &c. The *local* means are a strong solution of sulphate of copper (ʒss to f℥j, Dr. Coates), or the other astringent washes above recommended; also the tinc. ferri chlorid.

GLOSSITIS, OR INFLAMMATION OF THE TONGUE.

This disease may be produced in various ways, as by local injury, by the effects of mercury, and occasionally as an idiopathic affection. It is attended with swelling, which, in some cases, becomes excessive, so as to fill up the whole mouth, and even prevent deglutition and respiration; in such cases it is, of course, dangerous. The *treatment* is copious bleeding and leeching under the jaw, emollient poultices, saline cathartics, and, if the danger is imminent, free scarification longitudinally into the substance of the tongue.

TONSILLITIS, OR QUINSY.

An inflammation of the tonsils, one or both. If severe, it is accompanied by fever. The pain is increased on swallowing, and often extends to the ear. If both glands are affected, the swelling may be so great as to impede respiration. It naturally tends to suppuration in five or six days, after which great relief is experienced.

The *cause* is generally cold, though in many persons a predisposition to it exists.

Treatment.—An antimonial emetic may set it aside if given at the very forming stage. Bleeding, purging, and warm emollient poultices, kept constantly applied, and ice allowed to melt in the mouth, give great relief. After the fourth day, it will be better to favour suppuration, and then open the abscess.

The *chronic* form often causes a permanent enlargement of the tonsils, which may require amputation, or the application of the solid nitrate of silver, iodide of zinc, or tincture of iodine. It is most frequent in scrofulous children.

INFLAMMATION OF THE PHARYNX.

This affection, which constitutes what is commonly called sore throat, may be easily detected by an inspection of the pharynx, which presents a uniform dark-red colour, and is frequently spotted with whitish patches. The general symptoms resemble much those of tonsillitis, but there is seldom any marked degree of fever, and no difficulty of respiration. The leading signs are, redness at the back of the fauces, pain, and difficult deglutition, and a copious secretion of mucus from the part.

Treatment.—General bloodletting will seldom be required. If the pain be very severe, leeches may be applied externally to the neck, and the bowels should be freely opened by active purgatives. At the commencement, the inhalation of steam affords most relief; and as the

inflammation subsides, recourse may be had to astringent or stimulating gargles, nitrate of silver, and the internal use of ice.

GASTRITIS—INFLAMMATION OF THE STOMACH.

Inflammation of the mucous membrane of the stomach may be either chronic or acute. The latter, however, is very rare, as an idiopathic disease.

Causes.—The chief causes of acute gastritis are, external violence; acrid poisons (the most frequent cause); and cold drinks taken whilst the body is heated.

Symptoms.—Heat and acute pain over the stomach, increased on pressure, or by coughing, or deep inspiration; instant vomiting of the matters ingested; constipation and prostration of strength. The pulse is usually quick, small, and irregular; the tongue clean, and red at the point or edges. The skin is hot and dry; there is thirst, and a desire for cold drinks. The disease is attended with great depression of the heart's action through the influence of the solar plexus of the great sympathetic. As it advances, the face becomes collapsed, the extremities cold, and the patient lies in a state of complete prostration; cerebral symptoms now supervene, the abdomen becomes tympanitic, and death soon closes the scene.

The anatomical characters of acute gastritis are those of inflammation in general, but they may vary according to the exciting cause. Thus certain mineral poisons may give rise to peculiar states of the mucous membrane. In some cases, the inflammatory injection and thickening are confined to particular spots; sometimes they follow the course of the principal blood-vessels, and on other occasions the whole mucous membrane presents a uniform vivid or dark-red colour; but ulceration is rare.

Treatment.—The first indication of treatment in this, as in all other affections, is the removal of the exciting cause. Should the presence of any poison be suspected, the proper antidotes are to be at once administered, or vomiting excited; circumstances alone can determine an election. Blood must be freely drawn from the arm in severe cases, and the venesection repeated according to circumstances; leeches, also, should be freely applied over the epigastric region. The pulse will often be found to rise in force and fulness after bleeding. Warm fomentations, containing an anodyne, will be found useful in allaying the pain, but some prefer the immediate application of a large blister over the region of the stomach, and of sinapisms to the feet. The thirst may be allayed by the frequent administration of cold water or of ice, in small quantities, but it will be advisable to abstain from giving medicines by the mouth, except calomel, which is often well borne by the stomach, as long as acute inflammation exists. If any be given, they should be of the least irritating nature. It is more prudent to administer laxatives by the rectum, to trust to general bleeding and

strict regimen, with revulsives or counter-irritants; small doses of calomel and opium might in some instances be advisable, and if the disorder persists, mercury should be given, so as to produce gentle ptyalism. If gangrenous symptoms come on, give oil of turpentine and morphia.

CHRONIC GASTRITIS.

This is an occasional cause of the severer forms of dyspepsia, and is often attended with one or more ulcers in the stomach.

The *symptoms* of chronic gastritis are extremely various, both in number and intensity. The following, however, are usually present in well-marked cases:—Pain and uneasiness about the region of the stomach, particularly increased after meals; sense of constriction in the œsophagus, near the lower part of the neck; imperfect digestion, accompanied by eructation, nausea, and occasional vomiting of food, or of mucus streaked with blood; skin dry, but not warm; pulse nearly natural, but sometimes accelerated; tongue covered with a whitish fur, or red at the tip and edges, or dotted with red spots from development and injection of the papillæ. Emaciation is very obvious. The patient often exhibits symptoms of hypochondriasis, and the spirits become low as the disease advances. It may last for years, varying in its intensity.

Ulceration into the colon, liver, spleen, or peritoneum may occur.

The *post mortem appearances* are dark-coloured patches, with great enlargement of the follicles; thickening, softening, or hardening, of the mucous coat, with ulceration.

Causes.—It may result from the acute; but is usually an original disease.

Treatment.—The principal indications are fulfilled by the application of leeches to the region of the stomach, followed up by external irritation and a careful regulation of the bowels. Strict attention should also be paid to the diet. The patient should eat nothing but very light food, at regular intervals, and the general health should be improved by gentle exercise in the open air. In some cases, the stomach is so irritable that no food of any kind can be borne. Equal parts of lime-water and milk, given by spoonfuls at a time, may be tried, and very small doses of prussic acid; but if all these measures fail, it will be advisable to abstain from administering food by the mouth, and to support the patient by nutritious enemata. The most efficient *medicine* is nitrate of silver, which will generally cure uncomplicated cases; the dose is a quarter to one-third of a grain, with one-sixth of a grain of opium, four times a day; it should be increased up to one grain. After the subsidence of all symptoms, the tone of the digestive organs may be improved by mild tonics; but the best strengtheners will be found to consist in moderate exercise and a strict attention to diet.

DYSPEPSIA.

This term is often used to signify any derangement of the digestive organs; it more strictly imports "a depression of the functions of the stomach" (Wood); though there may accompany it symptoms of irritation.

Symptoms. — A vague sense of uneasiness in the epigastrium, extending to the shoulder, and greatest when the stomach is empty, but replaced by positive pain when it is full. This pain may be of a neuralgic character (*gastralgia*), or spasmodic. The appetite is much deranged; eructations of sour wind and regurgitation of undigested food often occur. Various disordered sensations, as headache, giddiness, cough, palpitations of the heart, low spirits, &c., are present. The tongue is covered with a whitish fur in the mornings; bad taste in the mouth; constipation; deranged hepatic secretion; dry skin; pulse often natural. Emaciation gradually comes on, attended with a pale, sallow skin. It may terminate in chronic gastritis.

Causes.—Sedentary life and errors in diet, which depress the energies of the stomach by first over-stimulating them; abuse of alcohol, opium and condiments, by wearing out the healthy susceptibilities of the stomach; whatever calls off the energies of the stomach, as excessive exercise, or study; the use of narcotics, as tobacco; the depressing passions; improper use of cold drinks.

The depressing influence, however produced, interferes with the secretion of the gastric juice, and the peristaltic action of the stomach.

Treatment. —Remove the cause by regulating the diet and exercise. The *diet* should consist of stale bread, mealy, well-boiled potatoes, milk, ice cream, butter if very fresh, wild meats in preference to domestic; of the latter, poultry, beef, and mutton, roasted or boiled; oysters raw or roasted. The *cooking* is of the greatest consequence. The *drink* should be generally water, — coffee and tea are injurious; wine of the best quality should be cautiously allowed, as also porter, occasionally. The food should be taken frequently, and in small portions.

Exercise is of great importance: it should be adapted to the state of the case. Horseback exercise is, on the whole, the best. Salt bathing is often of benefit.

The *medical* treatment should be such as to meet the various indications. A combination of tonics, laxatives, and antacids, usually answers well. Small doses of blue mass are often beneficial. Rhubarb, aloes, and magnesia are the proper cathartics; the mineral acids, especially the nitro-muriatic, are useful in deficient appetite with bad breath. In flatulence, use a combination of astringents and purgatives. The habitual use of alkalies depresses the stomach, and should therefore be avoided; the best are bicarbonate of soda, magnesia, and

aromatic spirit of ammonia. The shower-bath is useful if reaction is fully established.

Several symptoms which frequently accompany dyspepsia, and result rather from an *irritable* stomach may be briefly alluded to.

Cardialgia or *heartburn,* usually referred to the presence of acid in the stomach, is relieved by antacids.

Gastralgia or *Gastrodynia* is a true neuralgic condition of the stomach. It is best treated by opium, hydrocyanic acid, sinapisms, morphia endermically applied, bismuth, or nitrate of silver, cups to the spine, hot stimulating drinks, as ginger tea, &c.

Pyrosis, or *Water-brash.* — This occurs in painful paroxysms, often accompanied by cardialgia. The fluid comes up in repeated eructations of a thin glairy character, and usually when the stomach is empty. The remedies are bismuth, nitrate of silver, oil of amber, and nux vomica.

Spasm, or *Cramp,* occurs in paroxysms; the pain is often excruciating, with a *depressed* pulse, cool skin, &c. It requires opium, aromatics, sinapisms, &c.

Nausea and vomiting may be caused by offending matters in the stomach, as acid or undigested food. Again, they may be purely sympathetic. They should be treated by mild emetics if depending on acid accumulations; or by lime-water and milk, carbonic acid water, and aromatic ammonia.

Sick Headache is a frequent accompaniment of dyspepsia. It may depend on indigestible food, or acid in the stomach, and is best treated by magnesia, aromatic ammonia, tonics, or a calomel purge, if dependent on hepatic congestion. When habitual, it can almost always be relieved by giving a grain of sulphate of quinine, with one-twelfth of a grain of sulphate of morphia, in anticipation of the paroxysm.

ENTERITIS.

This term signifies inflammation of the mucous coat of the small intestines; although the muscular and serous coats may also be involved. It occurs in the acute and chronic forms.

Symptoms of the acute. — Pain of a griping character about the umbilicus, caused by a spasmodic contraction of the bowels, which precedes an operation and is relieved by it; tenderness on pressure; more or less diarrhœa, fever, and tympanitic abdomen, especially in children. If the muscular or peritoneal coat be attacked, constipation may take the place of diarrhœa. Ulceration is rare except from the presence of foreign bodies, as a grape-seed in the appendix. It is most apt to occur about the ileo-cœcal valve.

Causes.—Crude ingesta in the bowels, and cold.

Treatment. — Bleeding not usually necessary. Calomel the best purge, because the least irritating, to be followed by castor oil; but often it is not requisite, from the existence of diarrhœa, in which case give castor oil and laudanum, or magnesia, if there be acid. Regu-

late the diet; apply leeches to the abdomen over the painful spot. Dover's powder at night; the warm bath, especially for children; emollient poultices to the abdomen. If it does not yield in four or five days, use blue mass in combination with opium and ipecac., and apply a blister.

The *chronic* form is of common occurrence, most cases of chronic diarrhœa being of this nature. There is generally some febrile action towards evening. The discharges vary, being either feculent or bloody, indicating ulceration; or mucous, indicating colitis. In protracted cases, great emaciation occurs, with a dry skin, a red or gashed tongue, and depression of spirits. A frequent cause of its obstinate character is the presence of tubercles.

The *autopsy* reveals the usual evidences of chronic inflammation, as thickening, ulceration, &c., together with the existence of tubercles.

Treatment.—Opium is indicated in combination with ipecacuanha; castor oil and laudanum if there are acid accumulations in the bowels; chalk and opium if the discharges are excessive. At the same time use sulphate of copper in doses of $\frac{1}{6}$th to $\frac{1}{4}$th gr., with a little opium, three times a day. Nitrate of silver or sulphate of zinc are also useful, with sugar of lead and opium to check the discharges. In the advanced stage, when there is a low condition with a smooth tongue, the terebinthinates will be found useful; and if other means fail, *mercury,* pushed to a moderate salivation.

The external means are leeches, blisters, fomentations, and the hot salt bath. The *diet* should be carefully regulated as in chronic gastritis.

COLITIS OR DYSENTERY.

Dysentery is an inflammation of the mucous coat of the colon; it frequently also extends to the rectum.

Symptoms.—Griping pains, or *tormina,* of the abdomen, very severe before going to stool, and somewhat relieved by the discharges, which are very frequent, amounting sometimes to forty or fifty in a day. The dejections at first may be feculent, but afterwards they are small, and consist of mucus or blood, and sometimes of disordered bile. There is also constant straining at stool (*tenesmus*). In advanced stages the stools acquire a peculiar odour, the abdomen becomes tender and tympanitic, and often the precise seat of inflammation is indicated by the pain experienced on touching it. Towards the last, the discharges become profuse and watery, of a dark colour, resembling the washings of flesh.

Sometimes prostration sets in from the first; though generally in the beginning the condition is sthenic. It is sometimes associated with the typhous condition, which imparts to it a low and dangerous character, and has caused it to be regarded as contagious. Another complication is with miasmatic fever, especially in the United States.

Prognosis.—Mild cases recover in ten to twelve days; but frequently it is a dangerous and fatal disease, especially in hot climates and in crowded situations.

Morbid appearances.—Traces and effects of inflammatory action in various degrees are to be found in the rectum and colon. The mucous coat is more or less injected in several points, and certain portions of the cæcum and colon are either ulcerated or entirely disorganized, the membranes hanging by shreds into the interior of the bowel. The ulcers are sometimes small and numerous; at other times they are elevated, hardened, and covered with sloughy or fungous granulations. Some parts of the great intestine may be in a state of sphacelus; and more or less coagulable lymph, mixed with shreds of disorganized cellular tissue, adheres to different points of its surface.

Causes.—The chief causes of acute dysentery are, exposure to cold damp air; acrid indigestible food; spirituous liquors, and exposure to unwholesome exhalations. It prevails most in autumn, and is held by some writers to be contagious.

Treatment. — In mild cases, a full dose of castor oil with twenty drops of laudanum. If more severe, with much fever, bleed, and give a full dose of calomel, followed in a few hours by castor oil, after which use the *Oleaginous mixture.* If there is much pain and a hot, dry skin, small doses of the saline cathartics, especially Rochelle salts, with a little paregoric, are useful. *Opium* is almost indispensable; a full dose of Dover's powder may be given at night, and afterwards used in smaller quantities. *Mercury* will be generally required; three grains of calomel may be given with the opiate at night, after which small doses should be taken every few hours.

Acetate of lead is not useful in the early stage; but as an injection in hemorrhagic cases it is very beneficial. For the same indications, sulphate of zinc, sulphate of copper, and nitrate of silver, are often prescribed, in the advanced stage. By some, *Hope's acid mixture* is recommended.

The *local* means are,—leeches or cups to the painful spot, warm fomentations to the abdomen, blisters in the advanced stage, frequent injections of starch, or animal oils and laudanum, and large mucilaginous enemata to relieve the tenesmus.

Oil of turpentine and copaiba are often taken internally in the latter stages, with great benefit; they act as alteratives upon the diseased membranes. If connected with miasmata, quinia is the important remedy.

The diet should be very low at first, but the debility should be counteracted by animal broths, jellies, wine whey, &c.

CHRONIC DYSENTERY.

This is usually the result of the acute form. It is often complicated with chronic enteritis. The stools are much less frequent than in the acute variety, and they are more or less feculent, mingled with

mucus, and more rarely with blood. There is occasional pain on pressure, with some tormina and tenesmus. The pulse, skin, and tongue, are much the same as in chronic enteritis.

After death, thickening and ulceration of the mucous coat are generally observed.

The *treatment* consists chiefly in the regulation of the diet, occasional local bleeding, the hot salt bath, together with the occasional use of laxatives and of opium and ipecacuanha. The *alteratives* are particularly useful — as sulphate of copper, copaiba, and oil of turpentine. If there are evidences of ulceration of the rectum, an injection of sulphate, or acetate of zinc and opium, or of nitrate of silver, will prove advantageous.

Tonics may also be given with advantage in the chronic stage, particularly when the disease assumes an asthenic form. Those generally administered are cinchona, and the infusion of serpentaria, colomba, or simaruba barks. Great attention should at the same time be paid to the condition of the liver; the bowels must be kept regular, and all errors of diet, or exposure to damp, cold, &c., carefully avoided.

COLIC.

This disease is characterized by severe griping pains in the bowels, with costiveness, and frequently with vomiting. Colic may be produced by a variety of causes, the most common amongst which are, irritating ingesta, flatulency, or a morbid sensibility of the mucous membrane.

Symptoms. — Severe twisting or griping pain in the abdomen, particularly in the umbilical region or along the course of the colon; the pain is not increased by pressure, nor is there any fever, — circumstances which distinguish the disease from peritonitis and enteritis; it comes on in paroxysms, and in the intervals there is perfect, or partial ease; it usually comes on quite suddenly; the muscles of the abdomen are often retracted; the patient also complains of borborygmi, or rumbling noises from flatus in the canal. If very violent, there is great prostration of system, with a cold skin and feeble pulse. Occasionally there is vomiting, and that of a stercoraceous character, when the contraction is low down in the intestines.

Bilious colic is that variety occurring in the summer and autumn, produced by some hepatic disorder; there is often a jaundiced appearance of the skin and eyes, together with tenderness in the region of the liver, and vomiting of a bilious matter. It often occurs along with miasmatic diseases, and in the same regions.

Other varieties are the *gouty* and *neuralgic*.

Treatment. — The first care of the practitioner should be to determine, if possible, the exciting cause of the colic, and whether it be occasioned by an organic disease, such as hernia, intus-susceptio, tumours, &c. This done, and the complaint having been ascertained to be simple colic, he may at once administer anodynes combined with

cordials, and proceed to evacuate the intestinal secretions by the use of enemata and mild purgatives. For this latter purpose, the blue-pill will be sufficient, or castor oil with laudanum, together with hot fomentations.

In stomachic colic, with nausea, use a mild emetic, or copious draughts of warm water.

If cathartics will not act, use enemata freely, gradually increasing their strength.

In bilious colic, calomel and opium are the proper remedies, and, possibly, bleeding or cupping, and in malarious regions, quinine.

In the rheumatic and gouty forms, a mild cathartic, followed by Dover's powder and colchicum.

The neuralgic form requires anodynes freely, together with colchicum, aconite, belladonna, &c. In all the different varieties, if there be no head symptoms to contraindicate it, the inhalation of ether often affords prompt relief.

COLICA PICTONUM—PAINTER'S COLIC.

Cause.—Exposure to the poison of lead. M. Andral considers lead colic as a neurosis, in which the spinal marrow and abdominal plexuses of the great sympathetic appear to be the peculiar seat of lesion. The constipation seems to depend either on the abolition of the contractile motion of the intestines, or on the suspension of the secretion of the intestinal mucus.

Symptoms.—Violent pain at the umbilical region; sickness and obstinate constipation; pains in the wrists, ankles, and neck; headache; bitter eructations; and occasionally paralysis of some of the voluntary muscles.

Treatment.—The best mode of treatment consists in the free administration of purgatives with opiates, such as calomel and opium, followed by castor oil and laudanum; croton oil will sometimes be required to overcome the constipation. A warm bath should be given, with injections of a large quantity of warm water into the bowels whilst the patient is in the bath. If these measures fail, mercury should be used, to ptyalism.

Dilute sulphuric acid, made into a kind of lemonade, and extreme cleanliness, are the best preservatives from the poison of lead.

Paralysis of the limbs sometimes accompanies lead colic, and remains after the removal of that disease. Here great attention must be paid to the bowels, and on the least indication of costiveness the purgative salts should be administered. The diet should be generous; friction along the limbs with stimulating liniments should be practised, and the extract of nux vomica or strychnine administered internally. Great good is produced by supporting the paralytic limb in splints.

ILEUS.

This complaint consists of very severe colic with obstruction of the bowels, and generally ends in inflammation.

Symptoms.—Violent griping and twisting pains about the umbilicus, which is retracted; obstinate constipation; nausea, and vomiting of stercoraceous matter; tension and tenderness of the abdomen. The pulse is at first natural and the skin cool, but febrile symptoms soon set in, and are followed by hiccup, prostration, cold sweats, sinking, and death.

Morbid appearances.—Mechanical obstruction in some part of the intestinal canal produced by knots of the bowels; intussusception; adhesions; bands of false membrane; strangulation of the gut; organic constriction of its calibre; foreign bodies, such as fruit-stones, &c. The parts of the intestine above the obstructed point are generally dilated and inflamed, and in many cases the inflammation has extended to the peritoneum, producing its usual results.

Invagination of the intestine most frequently occurs in children, and, in addition to the symptoms already enumerated, may sometimes be recognised by the presence of a painful tumour over the invaginated portion of gut.

Treatment.—The medical treatment of ileus will seldom be of any avail, as may be readily inferred from a consideration of the pathological conditions with which it is connected. The forcible inflation of air per anum has been recommended. Copious enemata frequently repeated, thrown high up into the bowels, by means of a flexible tube, and mild purgatives given in moderate doses, regularly repeated, may be tried first. If they do not succeed, stronger purgatives may be tried, such as croton oil. But if the purgatives add to the sickness and pain, they should be suspended. Crude mercury in large quantities has been given by the mouth, and in some instances with relief. If inflammatory symptoms arise, they should be combatted by bleeding or leeches, and the warm bath. The operation of gastrotomy has been frequently performed for the cure of ileus, and there are two or three cases of success on record. The great objection, however, to its performance is, the obscurity and uncertainty of the symptoms. When the case seems hopeless, the patient's sufferings should be soothed with opiates, and his strength kept up by nourishing enemata.

PERITONITIS.

Causes.—Inflammation may exist at any point of the peritoneal sac, but the term peritonitis more properly belongs to inflammation of that portion which does not invest any of the viscera. The *causes* of peritonitis are the same as those of inflammation in general; besides which are, external violence, metastasis, disease of the mesenteric glands, obstruction of the bowels, the irritation produced by disease of neighbour-

ing viscera, and the effusion either of the contents of the alimentary canal, or of the urinary bladder, &c.

Symptoms.—Acute pain, commencing at a particular part of the abdomen, and gradually extending over the rest of the surface; rigors, followed by heat of skin; frequency and smallness of the pulse; in many cases, nausea and vomiting; constipation; anxious countenance; tongue dry, but not foul; respiration accelerated and costal; urine scanty. The patient lies on his back, with the thighs flexed, and cannot bear the slightest pressure on the abdomen, which becomes tumid or tympanitic. In addition to these general symptoms, others will present themselves, according to the vicinity of the part inflamed to any of the principal abdominal viscera. Peritonitis from intestinal perforation is characterized by the suddenness and the rapid progress of the symptoms, and the great accompanying prostration.

Morbid appearances.—Injection, by patches, of the sub-serous tunic; effusion of lymph, or a sero-purulent fluid, into the cavity of the abdomen; adhesions, by means of soft, whitish false membranes, between the folds of the intestines.

Treatment.—Bloodletting, to be repeated according to the patient's strength, &c.; leeches very freely applied over the painful parts, and warm fomentations, are the chief means on which reliance is to be placed at the onset of the disease, together with a full dose of calomel, followed by castor oil; small doses of calomel should now be given, until the mouth becomes sore; and the bowels must be kept open subsequently with gentle laxatives or enemata. If the tympanitis be troublesome, enemata containing turpentine or assafœtida may be administered for the sake of obtaining temporary relief. In peritonitis from perforation of the intestinal canal, the only hope of saving the patient lies in the instant administration of opium, in doses sufficient to arrest the peristaltic motion of the bowels. This gives us some time for the employment of other means, with a faint chance of success.

CHRONIC PERITONITIS.

Chronic peritonitis is sometimes a sequel of the acute disease; sometimes, on the contrary, it begins in a very obscure and insidious manner, and is attended in scrofulous subjects by a deposit of granules or tubercles external to the membrane.

Symptoms. — Slight occasional abdominal pains, often scarcely noticeable, increased by pressure; fulness and tension of the belly, particularly a deep-seated tightness, as if the integument and muscles glided over the tight and thickened peritoneum; feverishness and emaciation.

This disease is often attended by enlargement of the mesenteric glands, with which it is usually identical in symptoms,—also with ascites.

Morbid appearances. — The peritoneum thickened; the bowels

glued together; the abdomen containing more or less turbid serum; perhaps ulceration of some part of the bowels; the omentum thick, red, and fleshy.

Treatment.—Occasional leechings, blisterings, frictions, and flannel bandages to the abdomen; or warm fomentations and poultices, if the pain is very severe; nourishing diet; small doses of mercurials, and mild laxatives and antacids. If anæmia be present, use iron and iodine.

WORMS.

There are three species of worms which most commonly inhabit the intestinal canal—viz., the *ascaris lumbricoides, ascaris vermicularis,* and *tœnia.*

The *lumbricus* is a round worm, varying in length from four to twelve inches; the tail ends in a blunt point; the head is sharp, and set between three oblong tubercles.

The *ascaris vermicularis* is very thin, and does not exceed an inch in length, but it is usually shorter; the tail terminates in a fine point. It inhabits the rectum.

The *tœnia* is a very long, flat worm, articulated, and furnished with four suckers at the head. Two species of *tœnia* are met with in man. They infest the small intestine.

Worms very frequently exist in the intestinal canal without producing any irritation or inconvenience whatever; on other occasions, however, they are attended with the following symptoms: — disgust of food, or irregular appetite; nausea, vomiting, griping pains in the abdomen; tenesmus; disturbed sleep; irregular accessions of fever; sympathetic irritation of the nose and anus; diarrhœa, with slimy stools; foul breath; headache; dilatation of the pupils; strabismus; emaciation; and, in young children, cerebral disturbance, or convulsions. Ascarides often produce a sensation of itching about the anus, while the lumbricus occasions pain of a gnawing character in the umbilical regions. The stools should be constantly inspected, for the presence of the worm in them alone can render us certain of the correctness of the diagnosis.

Treatment.—The objects of treatment are, to destroy and expel the parasitical animals, and to prevent their return. For this purpose, various remedies, called anthelmintics, are administered. Common purgatives will sometimes suffice to expel the worms. Should these fail, we may employ the mucuna or *cowhage,* or turpentine. Calomel is often a very efficient anthelmintic, from the acrid bile that it pours out. It is particularly serviceable in cases of children. Other anthelmintics much employed are wormseed, or its oil, and spigelia.

For *tape-worm,* oil of turpentine is one of the best remedies, in doses of f℥ss to f℥ij, given either along with, or followed by castor oil. Lately *kousso,* the powdered leaves of an Abyssinian plant, and the oil of pumpkin seeds have been highly extolled in tænia.

M. Raspail regards camphor as a specific against ascarides; and in France and Italy the root of the pomegranate is employed with success in cases of tænia. The condition of the bowels should be carefully regulated, and all errors of diet avoided, for worms are mostly found upon children who are ill fed upon unwholesome and indigestible vegetable food. After the complete evacuation of the parasitical animals, a course of vegetable or mineral tonics has been recommended; but wholesome food, exercise, and a proper regimen, will be found the best means of preventing their recurrence.

DIARRHŒA.

Diarrhœa consists in copious and frequent alvine evacuations, which are generally fluid, without tenesmus or fever.

The *symptoms* are, frequent discharge of mucous or slimy stools, containing feculent or ill-digested matters, with griping pains, nausea, and foul tongue. The state of the skin is generally natural.

Causes and Treatment.—The causes of diarrhœa are very various, and so must be the treatment adapted for various cases.

1st. *Inflammatory diarrhœa.* This arises from irritation, inflammation, or ulceration of the intestines, and is a frequent attendant of fever, phthisis, &c. It is characterized by pain, tenderness, thirst, and slimy evacuations; and is to be relieved by small doses of hyd. c. cretâ, and pulv. ipec. c.; injections of starch and laudanum; rubefacients or fomentations to the abdomen; chalk mixture, &c.

2d. *Diarrhœa* from *unwholesome food*, or *irritating substances*, or foul accumulations in the intestines. This is a very common form, being often produced by unripe fruit, and it is in fact what is caused by a common dose of physic. This form of diarrhœa tends to work its own cure, which is best accelerated by a dose of rhubarb and magnesia or castor oil, followed by chalk mixture.

3d. *Diarrhœa* from *debility* and *relaxation.*—This form is apt to follow any of the others, and is to be recognised by the kind of constitution to which it happens, and by the freedom from active symptoms. The various vegetable and mineral astringents with opium are the remedies.

4th. *Diarrhœa* in *young children* often arises from the irritation of weaning, or from an unnatural quality of the milk, or from attempts to bring up children by hand. A very small dose of hydr. c. cretâ with rhubarb, followed by chalk mixture, with five or ten minims of paregoric, are the remedies. Baked flour or biscuit powder may be tried as food.

In all cases of diarrhœa it is important to attend to the skin, and to keep it warm.

CHOLERA MORBUS.

Causes.—Constant exposure to a high temperature producing con-

gestion of the liver; indigestible food; putrid miasmata; certain seasons.

Symptoms.—Violent griping pain, followed by frequent vomiting and purging of greenish bilious matter; spasms of the abdominal muscles, sometimes extending to the legs and arms; tongue dry; urine high-coloured, scanty, or suppressed; thirst urgent; pulse frequent, but soon becoming small and weak. As the disease continues, the spasms become more severe, the countenance anxious and collapsed; the strength is much reduced, and fainting occurs.

As cholera morbus depends on simple irritation of the mucous lining of the alimentary canal, the morbid appearances after death are not very remarkable, consisting in some injection or congestion of the vessels.

Treatment.—In the very early stage, use warm diluent drinks, the best of which is warm chicken tea; and apply a sinapism over the epigastrium. To allay the spasm and irritable state of the digestive canal, calomel and opium should be administered in small doses, as one-sixth of a grain of the former, and one-twelfth of a grain of the latter, every half hour; larger doses in violent cases, and then repeated injections of gruel or starch in large quantities, to bring away the irritating matters;—and opiates. Warm fomentations may be applied over the abdomen, or the turpentine, or ammoniated liniments. When the surface of the body becomes extensively cold, and symptoms of exhaustion appear, it will be necessary to administer stimulants, as camphor, ammonia, small quantities of brandy, &c., combined with aromatics. When the more urgent symptoms have been relieved, the discharge of the different abdominal secretions should be promoted by gentle laxatives, by enemata, &c.; and light nourishment may be permitted during the convalescence.

CHOLERA INFANTUM—SUMMER COMPLAINT OF INFANTS.

This disease seems to be peculiar to the United States. It prevails most extensively in large cities, during the hot months; and is one of the most fatal affections to which childhood is subject.

It occurs in children from four to twenty months of age, or during the period of dentition; the *second summer* of children is considered the period at which they are most liable to the disease.

It commences with a profuse diarrhœa, the stools being light-coloured and thin; this is succeeded by great irritability of the stomach, so that by constant vomiting and purging the child becomes languid and prostrate, often in a few hours.

The pulse is quick, small and often tense; the tongue is white and slimy; the skin is dry and harsh; the head and abdomen are hot, whilst the extremities are natural in temperature, or even cold. Towards evening there is fever, restlessness, and pain. Occasionally delirium occurs, manifested by violent tossing of the head, attempts to

bite, the eyes becoming wild and injected. Death may result in six hours; but generally the case is more protracted. The emaciation becomes extreme, the eyes languid and hollow, the countenance pale and shrunken, the nose sharp and pointed, the lips thin, dry, and shrivelled; the skin upon the forehead tight and shining. The child lies in an imperfect doze, with half-closed eyelids, insensible to external impressions.

The surface of the body is now cool and clammy, of a dingy hue, and often covered with petechiæ; the tongue is dark, and the fauces dry. The abdomen becomes tympanitic; the discharges from the bowels are dark-coloured, profuse, and offensive, resembling the washings of stale meat; in other instances they may be small, and consist of mucus and undigested food.

According to Dr. Condie, "the disease is evidently dependent for its production upon the action of a heated, confined, and impure atmosphere, directly upon the skin, and indirectly upon the digestive mucous surface, at an age when the latter is already strongly predisposed to disease from the effects of dentition, and from the increased development and activity of the muciparous follicles, which take place at that period."

Treatment.—The most important point in the treatment is to remove the child from a heated and impure atmosphere, to the pure air of the country. A nursing child should be confined exclusively to the breast; if weaned, to tapioca, arrow-root, or ground rice, and cool mucilaginous drinks. A tepid bath should be employed night and morning; the clothing should be light and dry, and the chamber well ventilated.

The gums should be examined, and if swollen and hot, they should be freely lanced.

Small doses of calomel, acetate of lead, and prepared chalk, will be found most serviceable in arresting the diarrhœa. The irritability of the stomach may be overcome by small doses of calomel, lime-water, and milk, or a few drops of spirits of turpentine; a spice plaster, or a blister applied over the stomach, will also be decidedly advantageous.

When there is much heat about the head, with injected conjunctiva and delirium, leeches should be applied to the temples, and cold lotions to the scalp. Stimulating pediluvia, and blisters placed behind the ears, will also be found extremely beneficial.

After the irritability of the stomach is sufficiently quieted, the addition of a small quantity of ipecacuanha to the calomel, chalk, and acetate of lead, will most certainly, according to Dr. Condie, promptly restrain the disordered action of the bowels, and complete the cure.

ASIATIC CHOLERA.

This disease has long been endemic in India. It reached Europe in the year 1831, and the following year, appeared in the United

States. It returned to this country in 1834, and again in 1847–8, since when it has been more or less prevalent in certain parts of the country, and appears to have become endemic amongst us. It is, no doubt, propagated by atmospheric influence.

Symptoms.—There is generally a *premonitory diarrhœa*, with occasional nausea, slight cramps, and heaviness about the head. In other cases, it commences suddenly with violent vomiting and purging, not of bile as in common cholera, but of a rice-coloured fluid, with excessive and painful spasms of the abdominal and other muscles; the pulse is quick, small, and soon disappears altogether; the skin is cold; the features collapsed; the urine altogether suppressed. As the vomiting and purging continue, the powers of life quickly fail; the extremities become deadly cold, and of a bluish colour; the pulse ceases to be felt at the wrist; the breathing is laborious; and the patient, who becomes very restless, is generally carried off within ten or twelve hours.

Morbid Appearances.—The blue colour of the extremities, which are rigid, remains after death. The fingers are flexed and shrunk, and the nails blue. The arterial system is empty; the venous, and particularly the right side of the heart, contains a quantity of dark, grumous, and uncoagulable blood; the latter fluid is deficient in salts and serum. When death has taken place rapidly, the intestinal canal is most frequently pale throughout; often it presents an injected appearance, either in spots or along continuous surfaces, from congestion of the veins; there are no ulcerations or other signs of inflammation, but the characteristic appearance is the absence of the epithelium, which often appears in shreds, looking like false membrane. The abdominal viscera are gorged with dark venous blood, and the urinary bladder is empty, and contracted into a hard ball.

Nature.—The peculiar poison seems to produce local irritation of the stomach and bowels, and at the same time, general depression, with a tendency to universal exosmose of the watery portion of the blood.

Treatment.—A successful mode of treating Asiatic cholera still remains to be discovered. Many of the Eastern physicians strongly recommend bloodletting in the commencement of the disease, to be followed up by calomel and opium. Others reject venesection, and endeavour to allay the most prominent symptoms—viz., the irritability of the alimentary canal and the spasms, at the same time using such means as are best calculated to restore the circulation to the surface of the body. This, perhaps, is the most rational mode of treatment that can be adopted; but, unfortunately, medical men are not agreed upon the means. Some prescribe nothing but ice-cold water, as long as the vomiting continues; others vaunt small and frequent doses of calomel, or calomel and opium; others advise the administration of emetics; and others again prefer stimulants, as cajeput oil, brandy, &c. In order to determine the blood to the surface, and allay spasm,

the extremities should be assiduously rubbed with warm anodyne embrocations; or when the vapour or hot air bath can be obtained, these may be employed with advantage. Dr. Stevens speaks highly of the saline treatment, which consists in the administration of the salts of soda and potash in any appropriate vehicle. In extreme cases, these salts have been injected into the veins with apparent advantage in a few instances. When the symptoms have subsided, and the patient survives, a stage of reaction often succeeds, and is attended with symptoms of a typhous character. The treatment should then be directed by the principles which have been laid down under the head of typhus fever.

SECTION II.

DISEASES OF THE RESPIRATORY ORGANS.

CATARRH.

THIS term is commonly used to signify an inflammation of the respiratory passages, accompanied with a discharge. If attended with fever, it is called *catarrh fever*. When epidemic, it is termed *influenza*.

It receives different names according to the part affected, thus *coryza*, when confined to the nose and adjacent sinuses; *laryngitis*, when seated in the larynx; *bronchitis*, when in the bronchial tubes.

CORYZA.

The inflammation is usually confined to the Schneiderian membrane, though it sometimes travels into the frontal sinuses, occasioning pain across the forehead; also into the maxillary sinus, causing pain in the cheek.

The *symptoms* are those so well known as "cold in the head." In infants it may prove dangerous from asphyxia produced while suckling; this is owing to the fact that an infant instinctively breathes through the nose; when sucking, they cannot breathe through the mouth, and the other passages being stopped up, the difficulty is occasioned. Chronic coryza is termed *ozæna:* it is attended with an offensive purulent discharge, and may be accompanied by caries, or associated with scrofula. The remedy which appears to act best is the injection of a solution of sulphate of zinc into the nostril, together with proper constitutional treatment, as iron, mercury, iodine, or cod-liver oil.

LARYNGITIS.

Inflammation of the mucous membrane of the larynx may be of every grade, though it is usually of a mild character, and easily curable. It has been divided into the *mucous, submucous, œdematous,* and *pseudo-membranous forms.* The mildest form is only a hoarseness attended with a laryngeal cough. If more severe, there is pain in the region of the larynx, increased by pressure, some difficulty of inspiration, accompanied by a bronchial sound, after which secretion comes on, with an amelioration of the symptoms. In other cases, the inflammation extends to the submucous tissue, when there are some thickening and swelling obvious to the eye, great pain, or a feeling as if a foreign body were present. The cough is in a very high key, and muffled; general febrile excitement; great difficulty of inspiration, accompanied by a loud bronchial or sharp musical sound; expiration is easy. The fauces are red; epiglottis turgid and erect, so as not to cover the glottis; hence there is difficulty of swallowing, the drinks being often returned through the nose. Violent coughing comes on in paroxysms, during which the face becomes swollen and livid, the eyes turgid and prominent, and there is more or less cerebral disturbance. The cough, which is at first dry, is afterwards attended with the expectoration of a thin and acrid secretion, which, should the case proceed favourably, becomes bland, viscous, and transparent, and gradually changes to a yellow.

Should the disease progress to a fatal termination, all the symptoms become aggravated; the mucous membrane of the larynx becomes swollen, and the rima glottidis so contracted as not to allow sufficient atmospheric air to pass to the lungs; hence there is great dyspnœa, with violent action of the respiratory muscles. As the rima becomes more contracted, the difficulty of breathing increases, the patient sits up in bed, tosses about his limbs, his eyes are prominent and tearful, and he dies apparently exhausted by his efforts; or, if a strong person, in a convulsive struggle. When the disease terminates more slowly, it is supposed that death is produced by blood, which is not duly aerated, circulating in the brain.

The œdematous effusion is most apt to occur in debilitated persons.

The *pseudo-membranous* variety constitutes one form of croup, and will be noticed as a distinct disease.

Causes.—The ordinary causes of inflammation are especially cold, and the inhalation of noxious gases, or of very hot air, or steam. Ordinary angina may extend into the larynx. The submucous variety may result from tonsillitis, and the *pseudo-membranous* form often accompanies scarlatina, small-pox, and measles.

Treatment.—In ordinary cases, leeching, if the pain is severe; purgatives, antimonials, low diet, rest of the voice, and warm fomentations. If it does not yield in four or five days employ *mercury* to a gentle ptyalism, and a blister over the throat.

In the worst forms of the disease, the danger is always great, and bleeding should *immediately* be employed freely, but not to syncope. Leeches and fomentations may also be applied, and the mercurial plan commenced earlier. If necessary, the epiglottis and margins of the glottis may be incised. Nitrate of silver has been recommended in this condition. In urgent cases, *laryngotomy* is to be employed as the only resource; but it will be of little use if too long delayed, or if the disease has extended down into the bronchi.

CHRONIC LARYNGITIS

This may be of every grade. It may proceed from repeated attacks of the acute form; from follicular inflammation of the throat, accompanied by a scrofulous diathesis; and from ulcerations connected with syphilis or tuberculosis. The common cases usually recover; the *ulcerations* often terminate unfavourably.

Symptoms. — Hoarseness and constant clearing of the throat. If more severe, partial or complete aphonia. *Ulceration* is indicated by a sharp pricking pain on speaking or coughing; occasionally there is dysphagia; also suffocative paroxysms. Sometimes the cough is loose, with a muco-purulent discharge.

A fatal termination is often given to it by its ending in phthisis.

Treatment.—Absolute rest of voice; diet according to the strength; occasional leeching to the throat; pustulation with croton-oil; together with a mild mercurial course.

In the *scrofulous* form. iodine or iodide of potassium and cod-liver oil would be indicated; in the *syphilitic* variety, mercury and iodine would be useful. The *direct* application of a strong solution of nitrate of silver (ʒss up to ʒij to f℥j of water), by means of a probang, around, and even within the glottis, is a most valuable remedy.

Before entering further into a description of the diseases of the respiratory apparatus, a tabular view of the thoracic regions, in relation to the signs of auscultation, &c., and based upon that occurring in *Meade's Manual for Students*, is presented to the reader.

REGIONS OF THE CHEST. — (Figs. 372, 373, 374.)

a. Anterior.	1. Supra-clavicular, 2. Clavicular, 3. Infra-clavicular, 4. Mammary, 5. Infra-Mammary, 6. Upper sternal, 7. Lower sternal.	*b.* Posterior.	8. Upper scapular, 9. Lower scapular, 10. Infra-scapular, 11. Inter-scapular.
		c. Lateral.	12. Axillary, 13. Infra-axillary.

TABULAR VIEW OF THE THORACIC REGIONS, IN RELATION TO THE SIGNS OF AUSCULTATION, ETC., MODIFIED FROM MEADE'S MANUAL.

(See Figs. 372, 373, 374.)

REGIONS.	FIG.	SITUATION.	NATURAL SOUND ON PERCUSSION.	INTERIOR CORRESPONDING PARTS.	SIGNS MOST COMMONLY PRODUCED THERE BY DISEASE.
1. Supra-clavicular.	1		Clear.	Apices of the lungs.	Dulness on percussion in phthisis; generally most on one side.
2. Clavicular.	1	Clavicles.	Very clear towards the sternum; clear in the middle; dull close to the humerus.		
3. Infra-clavicular.	1	From clavicle to the fourth rib.	Very clear.	Superior lobes of the lungs.	Irregular dulness on percussion, diffuse bronchophony, impaired respiration, and afterwards, cavernous rhonchus and pectoriloquy, in phthisis.
4. Mammary.	1	Between the fourth and eighth ribs.	Very clear; particularly by mediate percussion. In women, a clear sound can be obtained through the mammæ only by mediate percussion.	Middle lobes of the lungs; large bronchi in the upper part, near the sternum; the heart generally covered by the lungs, in the lower part of the left region.	Rhonchi in catarrh; more rarely phthisical symptoms. On the left side, dulness on percussion in hydropericardium and enlargement of the heart; increased impulse in hypertrophy, and increased sound of pulsation in dilatation of the heart; constant bellows or rasp sound in valvular disease.
5. Infra-mammary.	1	Between the eighth ribs and the margin of the cartilages of the false ribs.	Dull on the right side; on the left irregularly dull, or unnaturally resonant.	The liver on the right, and the stomach on the left side, covered only on the upper part by the thin margin of the anterior inferior lobes of the lungs.	Crepitant rhonchus in incipient pneumonia. Extinction of respiration in advancing pleurisy. Dry crepitation in interlobular emphysema.

6. Superior sternal.	1	Upper two-thirds of the sternum.	Very clear.	Large bronchi. Margins of the middle lobes of the lungs.	Bronchial rhonchi in catarrh. Only half the sternum dull on percussion in hepatization, the whole dull in extensive liquid effusion of one side.
7. Inferior sternal.	1	Lower part of the sternum and ensiform cartilage.	In the upper part clear; rather less so in fat persons. Below, sometimes more dull; sometimes tympanitic.	Above, margins of the lungs; below, the heart, liver, and sometimes the stomach.	Signs of diseases of the right side of the heart; dulness on percussion in effusion, or fat, in the pericardium, enlarged heart, &c.
8. 9. Scapular.	2	The scapula and the muscular ridge below them.	The pectoral resonance can be elicited from this region only by mediate percussion.	Middle posterior lobes of the lungs.	Catarrhal signs. Ægophony in pleurisy. Bronchophony in pneumonia.
10. Infra-scapular.	2	Below the inferior angles of the scapulæ and border of the serrati, to the level of the 12th vertebræ.	Clear on the upper portion, by striking on the angles of the ribs, or by mediate percussion. Below, dull on the right, and tympanitic on the left side.	Base of the lungs. The liver encroaches on the right, and the stomach on the left side.	Crepitant rhonchus and bronchophony in incipient pneumonia and œdema; ægophony in pleurisy; and dulness on percussion in both.
11. Inter-scapular.	2	Between the inner margin of the scapulæ.	Pretty clear by mediate percussion, or when the arms are crossed, and the head bowed forwards. The spinous processes of the vertebræ sound well.	The roots, and inner parts of the posterior lobes of the lungs.	Catarrhal signs. In the upper part, sound of respiration never destroyed in effusions into the pleura. In the lower portion, sometimes ægophony in pleurisy, crepitation and bronchophony in advancing pneumonia. Signs of diseased bronchial glands.
12. Axillary.	3	In the axillæ above the fourth ribs.	Very clear.	Upper part of the lateral lobes of the lungs. Large bronchi.	Dulness on percussion, cavernous rhonchus, pectoriloquy, &c., in pthisis. Catarrhal rhonchi.
13. Infra-axillary.	3	Between the fourth and eighth ribs at the sides.	Very clear; unnaturally so, in emphysema of the lung.	Middle of the lateral lobes of the lungs.	Dulness on percussion in advanced pleurisy; and on the right side, from enlarged liver. Ægophony in advancing pleurisy; crepitant rhonchus, and bronchophony in advancing pneumonia.

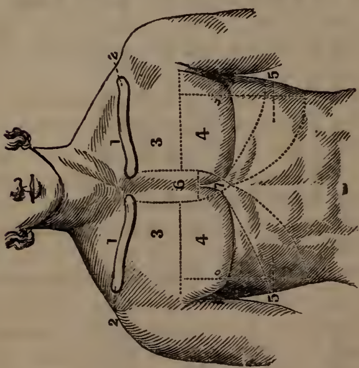

Fig. 372.

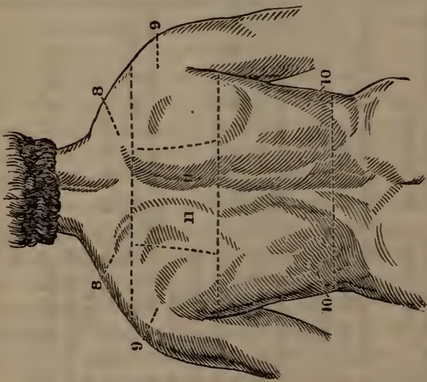

Fig. 373.

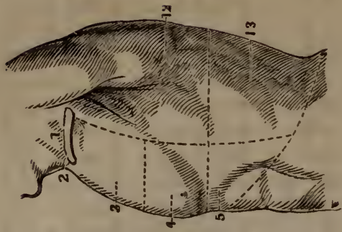

Fig. 374.

BRONCHITIS.

Inflammation of the bronchial mucous membrane occurs of every grade, from a slight cold up to a very dangerous disease.

Symptoms.—In a decided case, there is a sense of constriction of the chest, rather than of acute pain, increased by coughing; respiration more or less hurried; the cough is at first dry and painful, after which expectoration commences, at first, of a clear tenacious mucus, and afterwards becoming opaque, more abundant, and purulent. There is more or less fever. Usually all the painful symptoms abate on the appearance of expectoration, and convalescence is established in the course of a week or ten days; but it may run into the chronic form.

In more severe cases, the symptoms are much more intense. There is great difficulty of inspiration, attended with a wheezing sound, occasioned by a narrowing of the calibre of the tubes from effusion: the cough is more painful; there is greater soreness of the chest, together with increased fever. There are presented signs of a deficient aeration of the blood, such as a purplish appearance of the face and the extremities, cool skin, &c. This latter condition is very apt to come on in children, from the inflammation running down into the smaller bronchial tubes and often completely stopping them up; it is then sometimes called *capillary bronchitis*, and is attended with considerable danger. In the very aged it is also apt to prove fatal. Sometimes it assumes a paroxysmal, spasmodic character, when associated with asthma; again, it may be complicated with pseudo-membranous effusion, which however is rare in adults, though occasionally found in children, in whom it is very apt to prove fatal.

In adults, the disease is apt to be more circumscribed.

Another form of bronchitis, known as the *asthenic*, or *peripneumonia notha*, or *suffocative catarrh*, occurs in aged and enfeebled persons, though sometimes as an acute affection in the young. There is a sudden congestion of the whole bronchial mucous membrane, causing excessive dyspnœa, and a very copious expectoration of a thin and often bloody mucus, which causes suffocation.

Diagnosis.—Bronchitis may be confounded with pneumonia, pleurisy, laryngitis, and phthisis. Generally, however, the rational signs are sufficient to distinguish them; if not, the *physical* signs will always point it out. *Percussion* is clear throughout the chest, except in cases of great congestion, when there may be some dulness. *Auscultation* reveals very obvious changes. The three characteristic sounds are, 1, the *sibilant rhonchus*, if the disease is seated in the smaller tubes; 2, the *sonorous rhonchus*, if in the larger tubes; 3, the *mucous rhonchus* commingled with the others, heard as the disease advances, and as expectoration commences. Occasionally, the subcrepitant and submucous rhonchi may be heard, if there is commencing pneumonia. In certain cases, where one of the larger tubes happens to be plugged up with mucus, no sounds may be heard over that portion of the lung, but

percussion will reveal a clear sound, showing that it is not pneumonia; in such a case, if the patient be directed to cough, the usual sounds will return.

Causes.—Cold is the most frequent cause; the inhalation of irritating gases, or of hot air; also epidemic causes, and a gouty or rheumatic tendency. It is a frequent accompaniment of other diseases, as measles, enteric fever, hooping cough, small-pox, scarlet fever, and nearly all the pectoral diseases, especially pneumonia and phthisis. It may also arise from cardiac disease, causing congestion of the pulmonary vesicles.

Of the Sputa in Bronchitis.—In the first stage of bronchitis, the cough is dry, and so long as it continues so, the bronchitis must be considered as still at its commencement. At the end of a time, the length of which varies according to individual peculiarities, and according as the patients are or are not subjected to proper treatment, each fit of coughing is followed by the excretion of a clear, transparent, serous or watery mucosity, which is at first slightly saline, but afterwards becomes tasteless. As the disease advances, the matter expectorated is a glairy mucus, like white of egg; when it is poured from one vessel into another, it is observed to flow in one mass of extreme tenacity.

When the patient is attacked with violent fits of coughing, accompanied by considerable heat within the chest, as also by marked distress and general anxiety, the expectorated matter acquires remarkable viscidity, and resembles a little the jelly-like sputa of acute pneumonia. When the bronchial inflammation is accompanied by much fever, the viscidity of the sputa becomes also greater during the febrile paroxysm, so much so, that an inexperienced practitioner may mistake it for that of pneumonia; on the cessation of the paroxysm, however, the sputa will be found to have lost their viscidity. At other times, every species of expectoration is suppressed during the paroxysm; which indicates an increase of irritation of the mucous membrane. Some patients present, towards the end of the perspiration which terminates the paroxysm, a copious expectoration of thick, opaque sputa, such as is observed in the last stage of bronchitis; but this is only a temporary state, and the patient soon expectorates anew a clear limpid mucus, as before the febrile exacerbation. The sputa, in this stage, are frequently marked with some streaks of blood, arising from small vessels which are ruptured in the midst of an effort to cough. The blood is then *mixed* with mucus, but it is not *combined* with it, as happens in the reddened sputa of pneumonia. It often happens that in the midst of the transparent mucus, there are found, in greater or less numbers, small clots of a dull white; they do not come from the lung, but appear to be secreted in the pharynx and posterior part of the mouth, by the numerous crypts with which the mucous membrane of these parts is supplied. These clots have been erroneously considered

as portions of pulmonary tubercles, and consequently as one of the pathognomonic signs of phthisis.

As long as the sputa present the appearance above described, the symptoms of bronchial irritation do not improve; but according as the inflammation proceeds towards resolution, the sputa change their character. The mucus which forms them gradually loses its transparency; it is mixed with opaque, yellow, white, or greenish masses, which, scanty at first, continually increase, and ultimately constitute the entire sputa. Such an expectoration is ordinarily accompanied by marked remission in the different symptoms of bronchial inflammation.

Treatment.—The disease may sometimes be aborted, *at its very commencement*, by a full dose of opium, or Dover's powder taken at night, or by a copious draught of hot infusion of Eupatorium; but such a plan of treatment is not without some risk, on account of the liability to relapse on exposure. As a general rule, opium is not proper in the early stage, because it checks the bronchial secretion. In mild cases, confinement to a warm room, low diet, a saline cathartic, and some demulcent drink will usually suffice. In more severe cases, it will be proper to bleed, and purge, and employ the antimonials. For young children, the syrup of ipecacuanha is preferable to antimony. Cups and leeches are often required, either alone, or as adjuvants to the lancet. As the disease advances, the more stimulating expectorants will be useful, as the syrup of squill or seneka, to which opium, in some form, may be added, if expectoration is established.

Emetics are often of signal service in the bronchitis of infants; ipecacuanha should be preferred. A large warm poultice of Indian mush (to which a little mustard may sometimes be added), is very useful, especially for children.

If the disorder does not yield in the course of a week, the mercurial plan should be adopted, and a blister applied over the chest, or between the shoulders.

After the subsidence of the excitement, leaving only an irritation with oppression and expectoration, the condition of the bronchial membrane is different; it is now relaxed, and requires to be stimulated. The more stimulating expectorants are now called for, as myrrh, ammonia, carbonate of ammonia, and the balsams; at the same time the diet should be improved, and wine-whey and porter allowed. Such a condition often comes on in infants, and, if not properly treated, it is apt to end fatally. It is generally indicated by coldness of the surface, especially of the cheeks; whenever it occurs, the syrup of garlic, or assafœtida, and a nourishing diet, should be directed. The tincture of garlic, rubbed frequently over the chest, will be found an excellent application to children of enfeebled general health.

In cases of sudden congestion it is necessary to bleed largely, both generally and locally.

CHRONIC BRONCHITIS.

This disease may arise from repeated attacks of the acute form, and may last for years. In many of its symptoms it strongly resembles phthisis, for which it was formerly often mistaken, from want of proper means of diagnosis.

The *physical signs* are the sonorous, sibilant, and mucous rhonchi, heard throughout the chest, and the absence of the signs of chronic pleurisy, chronic pneumonia, and phthisis.

Treatment.—In the aged, in whom it has become habitual, it might be hazardous to arrest the discharge; hence the importance of a timely attention to it. General bleeding is very seldom necessary; occasional cupping or leeching will often be beneficial. The main reliance is upon the stimulating expectorants, one of the best of which is seneka, which may be combined with ipecac., or tartar emetic in minute doses. Still later, ammoniac, the balsams, as copaiba and tolu, and the terebinthinate preparations, will prove useful; and, if there are nervous symptoms, assafœtida and garlic. Where the cough and expectoration are considerable, Dr. Barlow[1] recommends the sulphate of zinc and extract of conium, one grain of the former and four of the latter, two or three times a day. Constant counter-irritation should be kept up over the chest, by means of repeated blisters, tartar emetic ointment, croton oil, or pitch plasters. The remedy, however, mainly to be relied on, is a gentle but protracted mercurial impression. Inhalations of the vapour of tar, chlorine, and iodine are often of benefit. Tonics are required in debilitated cases, together with a nutritious diet, warm clothing, and out-door exercise, and in some cases, cod liver oil, iodine, and change of air.

CROUP.

The essential character of this disease is a combination of an inflammation of the larynx, and a spasmodic action of the muscles about the glottis. *Mere spasm* is not croup.

There are two distinct varieties, the catarrhal and the pseudo-membranous; the former a very curable disease, the latter a very fatal one. The English writers do not recognise the catarrhal variety.

Catarrhal croup.—The symptoms are similar to those of catarrh, and often precede the spasm; there may be a *croupy cough* for some time previous. The paroxysm comes on suddenly at night, the child awaking with the characteristic sound, consisting of the peculiar cough, combined with a shrill inspiration. This may continue for some time, with great restlessness, jactitation, and distress. After a time the skin becomes cool, the pulse feeble, the face purple, and general re-

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[1] Practice of Medicine. Philadelphia, 1856.

laxation; the paroxysm now usually gives way, leaving behind a febrile condition. The paroxysm may, however, return again the following night, and so continue for some time, or it may subside spontaneously. It may prove fatal, either by producing asphyxia in the paroxysm, or from the supervention of bronchitis, accompanied by excessive expectoration. It generally depends on a simple laryngitis.

In the *pseudo-membranous* form, the early symptoms may be those of catarrhal croup; or they may be, from the first, of a peculiar character, the little patient going about with a muffled cough and voice, which, after a while, become entirely suppressed; this is an extremely dangerous symptom, as it arises from the exudation of the false membrane, which can be frequently seen on inspection of the throat. In favourable cases, the character of the secretion changes, becoming mucous; this occasions a loosening of the exudation, which may be then thrown off in a tubular form.

The cough, which was at first dry, or attended with a scanty muco-sanguineous expectoration, now becomes husky and suffocative, and is frequently attended with abortive efforts to excrete what is felt in the trachea; the sense of suffocation is increased, and the fits of coughing are accompanied by the expectoration of a glairy mucus, containing shreds of the adventitious membrane. As the disease advances, there is total absence of any distinct remissions; the pulse becomes accelerated, small, weak, and irregular; and the cough is less frequent, less audible, but suffocative. If a fatal termination is approaching, the patient tosses about in great distress; seizes on objects around him, and grasps them convulsively for a moment; throws his head back; seizes his throat, as if to remove some obstacle to respiration; makes forcible efforts to expand the lungs; and, after a variable duration of such sufferings, seldom above twenty hours, dies, either with signs of convulsive suffocation, or those of complete exhaustion of vital energy. Such is the course of the severe form of croup, when left to nature, or when unchecked by treatment.

The cause of the peculiarity of this form of croup is probably to be looked for in the blood. It very rarely attacks a child under one year of age; and it may be that, after this period, the blood becomes more plastic in its character, causing a tendency to the fibrinous exudation. Certainly, it cannot be owing to any violence in the inflammation, since this is often scarcely noticeable. The membranous effusion often extends down to the ramifications of the bronchi. Sometimes it begins in the bronchi and extends upwards.

Treatment of catarrhal croup. — In the paroxysm, give an emetic, of which the dose must be larger than common; the best is tartar emetic; a quarter of a grain is the dose for a child two years old. In mild cases ipecacuanha or powdered alum, will be sufficient. Repeat the emetic every ten or fifteen minutes till it operates, and at the same time employ the warm bath. This treatment is to be repeated if the case does not yield; after which bleeding or leeches.

If the spasm is not relaxed by this mode of treatment, a tobacco cataplasm may be put around the throat, and its effects carefully watched. The remaining catarrh is to be treated by a dose of calomel, and small doses of the nauseating expectorants, as syrup or wine of ipecacuanha. In the more advanced stages, seneka, or *Coxe's hive syrup* may be employed. Counter-irritation should be used at the same time, and if inflammation remain, small doses of calomel. In debility, use carbonate of ammonia.

The treatment of the *pseudo-membranous* form is essentially the same as the foregoing, only more decided, with the addition of something to correct the plasticity of the blood; mercury is the best. After bleeding or leeching, give a purgative dose of calomel, and afterwards one grain every hour. The *alkalies* — especially carbonate of potassa—have been highly recommended with the same view.

In great debility, stimulants must be employed, as carbonate of ammonia, wine whey, &c., together with the most stimulating expectorants. To favour the expulsion of the false membrane, prompt and vigorous emetics should be occasionally employed, — such as will not prostrate the system, as sulphate of zinc or sulphate of copper, or, what is better than either, alum in teaspoonful doses, suspended in molasses or honey. *Tracheotomy* is resorted to when all other means fail.

SPASM OF THE GLOTTIS,

Or *spasmodic croup*, as it is sometimes very improperly called, is very different from the preceding disease. In consists in a sudden choking fit, caused by a spasm of the muscles that close the glottis. There is no fever, nor any morbid appearances about the throat; the disorder is purely functional. It occurs in children, especially during the irritation of teething or weaning. The child suddenly loses its breath, tosses up its arms, turns bluish about the mouth, and when it recovers its breath makes a long crowing inspiration. This complaint is often fatal.

During the fit, the best remedy is to sprinkle a little cold water on the child's face; in the intervals the bowels must be opened, the diet rendered light and digestible, and the child put into the best possible state of general health. Very small doses of prussic acid with an alkali are sometimes of service.

PERTUSSIS—WHOOPING-COUGH.

This affection is contagious; it seldom occurs twice in the same individual, and particularly attacks children; but adults are liable to it, if they have escaped it in their childhood.

Symptoms.—It commences with symptoms of common *cold*, or *catarrh*, which may last for some days; the cough then becomes convulsive, and recurs in fits at various intervals. The fits may last a

quarter of an hour or more. Each fit is composed of a quick succession of sonorous coughs, with scarcely any perceptible inspiration between; but at intervals the expirations of coughing are suddenly interrupted by a very deep, sonorous inspiration, or *whoop*, which constitutes the pathognomonic sign of this disease. The peculiar whooping inspiration depends on spasms of the glottis. The face becomes swollen and livid in the paroxysm, and particularly during the whooping. The fit terminates by the expectoration of a colourless and scarcely frothy phlegm, and in many cases by vomiting also. The paroxysms at first recur several times every day, being always more severe towards evening, but less so during the night. After a certain time, they only return in the morning and evening; and towards the end of the disease, in the evening only. The duration of whooping-cough varies from a few weeks to several months. Before it terminates, the paroxysms become shorter, lose their peculiar characters, and are attended by an expectoration more decidedly mucous. This disorder may be complicated with bronchitis, or pneumonia; which are the chief sources of danger:—or it may cause cerebral symptoms, or sometimes a real apoplexy. The younger the child, the greater the danger. In some cases, the disease degenerates into a chronic mucous catarrh, with emaciation, and other symptoms resembling phthisis. In the intervals of the paroxysms, the patient coughs but little, preserves his appetite and strength, and has rarely any fever, except in the case above mentioned, or in the onset of a very severe attack.

Physical signs.—In the intervals of cough, the respiratory murmur varies on different points of the chest; at one part it is lost; at another it is slight; at a third it is puerile: there is some degree of *sibilus* and *crepitus*. The sound of the chest, on percussion, is good and unimpaired. The lungs do not become inflated during the strong inspiratory effort producing the whoop; for not only is the rima glottidis spasmodically affected, but in all probability the whole of the ramifications of the respiratory tree participate in this morbid action; for, during that period, if the ear is applied to the chest, no rhonchus or respiratory murmur is heard, except for a moment between each cough. The great tendency of pertussis in young children to pass into pneumonia, œdema pulmonum, or intense bronchitis, makes frequent auscultation of the chest very necessary.

At the first invasion, this disease may be mistaken for croup, or suffocative catarrh.

Morbid appearances.—The most probable theory of the nature of whooping-cough is, that it is a peculiar irritation of the laryngeal branches of the *par vagum*. When it terminates fatally, it is usually upon the supervention of peripneumonia or œdema pulmonum; in the first case, the lung will be found to contain sanguinolent serum, and here and there a lobule hepatized; in the second, a large quantity of highly spumous and colourless serum follows the scalpel on section of

the pulmonary tissue. In some cases, the meninges of the brain are much injected; in rare instances, there is also some effusion.

Treatment.—In the early, or *catarrhal* stage, a purge should be given, followed by syrup of ipecacuanha; if the bronchitis be severe, leeches and the other means are to be used, already mentioned. In the second, or *nervous* stage, the indication is to equalize nervous action, and relax the spasm; the antispasmodics and narcotics are the remedies; assafœtida is especially useful, also belladonna and hydrocyanic acid. *Alum*, in doses of one or two grains three times a day, is highly spoken of by Dr. Meigs. Frictions of oil of amber, tincture of garlic, &c., to the spine, are also very useful as adjuvants. The Germans recommend a combination of carbonate of potassa and cochineal.

In the advanced period, tonics, as quinia, sulphate of zinc, and iron if there is anemia, together with change of air, should be employed. *Vaccination* is said to render the disease much milder.

SPASMODIC ASTHMA.

Asthma is caused by a spasm of the muscular fibres encircling the bronchial tubes, and especially the smaller ones.

The existence of these muscular fibres was proved by Reisseissen, and has been confirmed by Dr. Williams, Valentin, and others, who have produced contraction of them by galvanism.

The *exciting* causes of the purely spasmodic variety of asthma are those which impress the nervous system, as strong or peculiar odours, mental emotions, and particular states of the atmosphere, and especially, irritation of the stomach and bowels.

The *precursory* symptoms of asthma are, languor, sickness, flatulency, and other dyspeptic symptoms; heaviness over the eyes, and headache; uneasiness and anxiety about the præcordia, with a sense of fulness and straitness in this region and in the epigastrium. In some cases pain is complained of in the neck, with unusual drowsiness and stupor.

Symptoms.—The attack of spasmodic asthma takes place generally about one or two in the morning, and during the first sleep. The patient suddenly awakes with a sense of suffocation, great tightness at his chest, difficulty of breathing, and excessive anxiety; he assumes with great eagerness the erect posture, and cannot bear the least incumbrance about the chest. The respiration is wheezing, interrupted, and laborious; the shoulders are raised, the elbows directed backwards, and every effort made to enlarge the thorax. The countenance, which was at first pale and anxious, becomes, especially in plethoric habits, suffused or bloated, and covered with perspiration. A considerable quantity of pale urine is voided at the commencement, or previous to the accession, of the paroxysm; and the lower extremities are usually cold. The pulse is generally quick, weak, and somewhat

irregular. During the fit the patient has commonly an instinctive desire for cool air. When the fit has continued from half an hour to one, two, three, or even four hours, some degree of cough and expectoration comes on, which relieved the patient; and after a brief period, his respiration, pulse and feelings assume their natural state.

Such is the common course of a first and moderate attack of this disease. Occasionally the patient has but one such fit, but more generally a slight constriction of the chest is felt through all the succeeding day, and the paroxysms return at the usual period of the night; this may occur for several nights, and at last the patient is altogether released from the attack. The disease may be suspended for several months, but it is liable to recur from changes of air, errors of diet, and the operation of other causes.

Physical signs.—In spasmodic asthma, during the fit the chest does not sound well on percussion, and the respiratory murmur is indistinct, even on the most forcible inspiration. But if the patient, after holding his breath a short time, be desired to breathe again quietly, the spasm will be for a moment overcome, and the entry of air into the cells will be heard in a clear and sometimes puerile sound; after one or two inspirations, the spasm again comes on, and the respiration becomes as dull as before.

In treating of the pathology of this disease, it was stated that the muscular fibres were in a state of spasm during the paroxysm; the obstruction to the entrance of the air into the small bronchi and vesicles thus produced is obviously the cause of the diminution of the respiratory murmur. By this contraction also the lungs are in a manner collapsed within the chest, and the parietes of the thoracic cavity, pressed by the atmospheric weight on them, lose that sonorous elasticity produced by a fulness of their aerial contents.

Complicated asthma. — A pure spasmodic asthma, affecting lungs otherwise healthy, is by no means common. In general there is some disease of the heart, or some chronic bronchitis acting as a source of permanent congestion, which both adds to the difficulty of breathing, and predisposes the parts to be more easily affected with fits of spasm.

Sometimes a severe attack of *dry catarrh* is aggravated by spasm. This constitutes the *bronchial asthma* of Andral.

Morbid appearances. — The changas which have been noticed in those who have died of asthma are to be regarded chiefly as accidental occurrences, or associated maladies, and, perhaps, more frequently, as the remote results of repeated or protracted attacks. No lesions sufficient to account for the phenomena of *uncomplicated* asthma could be detected by Laënnec, Andral, Cruveilhier, Bouillaud, and many other investigators. The most common consequences of the disease are, chronic inflammation and dilatation of the bronchi; the different varieties of emphysema and œdema of the lungs; hæmoptysis; tubercular deposits, with which asthma may be associated from its commence-

ment; hypertrophy and dilatation of the cavities of the heart; atrophy of the heart; effusions into the pericardium; effusions into the pleura; and, in some severe cases, congestions or effusions within the head, giving rise to coma, or apoplexy.

Treatment.—The indications during the intervals are, to strengthen the general health and avoid all derangement of the stomach by improper diet, and irritation of the lungs by unwholesome air.

The treatment of the fit consists in administering narcotics and antispasmodics. These should be given, if possible, as soon as the *first sensations* are felt, and then they may avert the attack; and it is noticed, that those do most good which produce expectoration. Strong coffee; laudanum and ether; and stramonium smoked as tobacco, are the most trustworthy. Inhalations of ether or chloroform are often very effectual, but should be used with caution, and never in cases of congestion, or where there is a gouty tendency, or cardiac disease. The same remarks apply to the smoking of stramonium.

Ipecacuanha first given in an emetic dose, and afterwards in small quantities, so as to keep up a constant nausea, sometimes has a powerful effect on spasmodic asthma. The tincture of *lobelia inflata* (Indian tobacco) is much used in asthmatic cases, given in doses of f℥i every half hour; it is nearly allied in its operation to stramonium and tobacco, and often succeeds in checking the paroxysm when given shortly before its invasion. Bloodletting is only required if there is inflammatory complication. If of a gouty character, the wine of colchicum should be given to nauseate.

In the interval, the treatment consists in attending to the patient's general health.

PNEUMONIA.

This is an inflammation of the parenchyma of the lungs. Three well-marked stages of the disease are exhibited, marked by characteristic pathological conditions of the organs.

The *first* stage is that of engorgement or congestion; the lung is reddened, is more dense, with occasional slight effusion, but no consolidation; air still penetrates its vesicles; it floats upon water, and crepitates on pressure. When pressed, a frothy serum exudes.

The *second* stage, or that of *hepatization*, is characterized by a still greater congestion and effusion into the vesicles and smallest bronchial tubes, and into the areolar tissue; the matter effused is either blood or fibrine. When cut open, the lung has a granular appearance, and is consolidated; it sinks in water, does not crepitate on pressure, and when pressed, emits a bloody serum. The transition of the first into the second stage is gradual and partial.

The *third* stage is that of *suppuration*; called, also, *gray hepatization.* The colour of the lung is a grayish-yellow; it is still solid and smooth; the effused matter is converted into pus. Portions of the same lung may be, at the same time, in the second and third

stages. If the suppuration be circumscribed, it constitutes a *pulmonary abscess;* and inasmuch as very extensive suppuration would destroy life *before* the formation of an abscess, by the complete disorganization of the tissue, the occurrence of pulmonary abscess is not to be regarded as a very dangerous sign.

In asthenic cases the disease cannot advance beyond the first stage before softening occurs, — the whole tissue being reduced to a pulpy mass, termed *splenization.*

Pneumonia may be single or double; in other words, it may attack but one lung or both at the same time. In one and the same lung it may be general or partial, attack the upper or lower lobe, be confined to the base, the root, or the centre (*lobular pneumonia*). It has been said, that all these different seats of pneumonia have been equally frequent. Some numerical results will settle the question. Out of two hundred and ten pneumonias, there were—

On the *right* side	121
" *left* side	58
Both sides (*double*)	25
Cases where the seat could not be detected	6

Another form is named *lobular pneumonia*, where numerous little distinct spots, supposed to be lobules, are affected; it is usually the result of bronchitis, and is generally met with in children. Each lobule will run through all the three stages, hence abscesses are not uncommon in this form of the disease.

It has been asserted that the upper pulmonary lobes are scarcely ever attacked with inflammation. This statement is not correct; those lobes are often affected, but not so frequently as the lower lobes. Morgagni, Frank, and Broussais, who draw their conclusions from dissections, state that the upper lobes are most frequently the seat of inflammation; Laennec and Andral, on the other hand, who included cases of recovery in their calculation, found the lower lobes to be most commonly inflamed. This discrepancy may be reconciled, as Dr. Williams observes, by assigning as the cause of it the fact, that *inflammation of the upper lobes is the most frequently fatal*, and, according to other observers, generally dependent on the presence of tubercles.

Gangrene is apt to result in depraved constitutions. In some, there is a peculiar tendency to it, even without any great previous inflammation. Sometimes the gangrene may be diffused; at others it may be in isolated spots.

The term *vesicular pneumonia*, or *capillary bronchitis*, is given to that variety of the disease when there is a deposition of pus in the minute bronchial tubes, looking like miliary tubercles.

Symptoms.—There is generally a decided chill at first, followed by fever; at the same time, or soon after, pain more or less violent is experienced in the side, breast, or back; it is occasionally acute, when a

complication with pleurisy may be inferred, since the true *lung pain* is rather dull, and is often referred to the epigastrium, or to the nipple on either side. Respiration is quickened; the cough is at first dry, as in low typhoid cases, and attended with bloody expectoration from the first. The *sputa* are viscid and tough, not very copious, and of a *rusty colour*, arising from a uniform mixture of blood, very different from the *streaked* appearance of the sputa in acute bronchitis, though this kind is also seen if the disease is complicated with bronchitis. Occasionally they consist almost of pure blood, and in typhoid cases are of a black colour.

The decubitus is usually dorsal, unless there is pleurisy. Headache is a very common attendant, arising from a deficient aeration of the blood in the brain. The flush on the face has a darkish hue, often circumscribed, and confined to one cheek, according to some observers, on the same side as the disease. The blood when drawn presents a decided cupped appearance.

In certain cases of pneumonia the above symptoms are often remarkably masked; hence in every doubtful case of fever it is proper to examine the chest.

Physical Signs.—In the first stage, or that of congestion, there is slight dulness on percussion, and diminished respiratory murmur, but very soon the characteristic *crepitant rhonchus* is perceived, especially if there is a rusty sputum. Sometimes it is not heard except on deep inspiration. On the other parts of the chest the respiration may be puerile. The crepitant rhonchus is caused by the separation of the adherent walls of the vesicles in inspiration, and resembles that caused by rubbing a lock of hair between the finger and thumb close to the ear. This sound indicates engorgement of the lung; whilst it exists, it is a proof that in several points at least, the inflammation has not passed the first stage. As long as the natural respiratory murmur predominates over the crepitation, we should infer that the inflammation is slight; on the other hand, when the crepitation prevails so as altogether to mask the respiratory murmur, it is a certain indication that the pneumonia has made progress, and that it has a tendency to pass to the second stage. These phenomena soon change, either by the resolution of the disease, or by its making further progress. In the former case, the crepitation diminishes in extent and intensity; the murmur of respiration approaches its natural state; the sound of the chest becomes less dull, and its movements more regular.

Second stage.—The second stage of pneumonia is that in which the lung presents that change which is called by Laennec *red hepatization.* In this condition, the cells being obliterated, while the large tubes remain pervious, dulness on percussion, bronchial respiration, and a loud resonance of the voice (*bronchophony*), are produced; the extension or intensity of these signs furnishes, within certain limits, an accurate measure of the extent or intensity of the disease. The *bronchial respiration* specifically marks the second stage of pneumonic

inflammation; often, at the same time, the crepitant rhonchus may be heard in the adjacent parts.

If the patient recovers from the second stage, and the infiltration diminishes, so that the air is again admitted to the minute tubes and vesicles, this is announced by a return of the *small crepitation*, which is of course favourable.

Third stage.—In the *third* stage, the diseased lung becomes infiltrated with a purulent matter, which is generally consistent at first, but soon acquires the liquidity of common pus. In this stage, a peculiar muco-crepitating rhonchus is heard, at first in some points, then in the whole of the affected part. It is usually announced by the recurrence of the chill, and the expectoration of a "prune juice" sputum.

Convalescence commences by the end of the first week, if the disease has not progressed beyond the first stage; at the end of the second or third week, if it has advanced to the second stage; and, if it has proceeded to the *third* stage, the period of recovery will depend altogether upon the strength of the constitution, and the amount of tissue involved.

When an *abscess* forms in a hepatized lung, the passage of air through the liquid will be indicated by the gurgling or cavernous rhonchus; and when the cavity has been emptied of the pus by expectoration, pectoriloquy and the cavernous respiration will be added to this sign.

Pneumonia may also terminate in *gangrene;* but this is nearly as rare a termination as abscess. The distinctive physical sign of gangrene is the fœtid odour emitted from the diseased part in respiration and cough; and the expectorated matter is also extremely fœtid. This change is usually attended by a collapse of the features, and great prostration of the vital powers.

Occasionally the inflammation may be so confined to the centre of the lung, as not to be evident by the physical signs: in such a case, the rusty sputa become a valuable indication.

In the pneumonia of old persons, the crepitant rhonchus is not heard, because the effused matter is not tough enough to afford the sound; but it is replaced by a submucous and subcrepitant sound.

The signs of *lobular pneumonia* are not always certain. It may be *presumed* to exist, if the inflammation occurs in a child; especially after bronchitis. A submucous sound is first heard throughout, followed by some crepitus and bronchial respiration.

Pneumonia is occasionally complicated with *hepatitis,* especially where the lower lobes are involved; in such a case, there would be tenderness, we presume, under the ribs, and some yellowness of skin. If associated with *miasmata,* it would assume a paroxysmal form. In *typhoid pneumonia,* there is less pain, an expectoration of pure blood, or else of a very dark matter, general feebleness, dry tongue, sordes, no crepitant rhonchus, but a subcrepitant and submucous

sound. Pneumonia sometimes developes tubercles in the lungs in those who are predisposed.

Treatment.—This should be accommodated to the various stages of the disorder. In the first stage, in good constitutions, *free bleeding* is demanded, and it may even be proper to repeat it. If this be postponed till bronchial respiration occurs, it will do but little good. In the commencement of the second stage, bleeding may still be practised. It should be followed by an active purge, after which laxatives will suffice. Next, commence with the antimonials; the one-sixth to one-eighth of tartar emetic every two hours. If the skin be hot, use the refrigerant diaphoretics. After two or three days of such treatment, a full dose of Dover's powder, together with two or three grains of calomel, should be given at night.

In the second stage, general bleeding should be very cautiously employed. *Cups* may, however, be freely applied with advantage, followed by blisters, and here the mercurial plan should very soon be commenced; calomel and Dover's powder being given every few hours, until salivation is produced. Still later, the stimulant expectorants may be used, especially seneka, with ipecacuanha, or tartar emetic and opium.

In gangrene, the stimulant and supporting plan is demanded; as quinia, carbonate of ammonia, wine or brandy, together with creasote, chloride of lime, and mineral acids.

Another mode of treatment recommended by some authorities, (Rasori), is by large doses of tartar emetic in the early stage, commencing with one-quarter of a grain, every hour, and gradually increasing up to one grain. This plan may prove effectual, but there is risk of producing gastro-enteritis, and of deteriorating the blood.

In *bilious pneumonia*, the only modification of the treatment is to commence with the mercurial plan immediately, along with the bleeding.

In the *miasmatic* form, quinia should be given in the apyrexia.

In *typhous pneumonia*, general depletion is inadmissible; cupping and blistering may, however, be employed; and especially the early use of *mercury*, combined with opium and ipecac., and the timely resort to carbonate of ammonia and wine.

Chronic pneumonia is to be treated by moderate topical depletion, blisters, and a mild protracted course of mercury.

PLEURITIS, OR PLEURISY.

Symptoms.—Fever, acute pain in the side, hurried and interrupted respiration, *dry* cough, and a hard resisting pulse, are the marked symptoms of this disease in its early stages. The pain is often intense, all motions of the thorax increase it, and the affected side is fixed and motionless. The patient complains of intense heat within the chest, and there is occasionally an extreme tenderness of the integuments. The pain is usually felt below the breast; but it may be felt in the

shoulder, the axilla, the lumbar region, or lower portion of the right hypochondrium. Sometimes the pain is wandering and fugitive, and it is not till the lapse of some days that it becomes fixed and continued. In this case it is often taken for a mere rheumatic pain. The pain, after continuing for forty-eight or sixty hours, in general diminishes or ceases altogether; and this coincides with an effusion. But in some severe cases the pain continues, with slight remissions, long after copious effusion has occurred, or even remains unabated up to the period of death. Sometimes, after having disappeared, it shows itself anew with great violence; this is a sure sign of the return of the inflammation. During the first stage, the patient seldom lies on the affected side, in consequence of the position causing increase of pain. The rule generally is, that in the first stage he lies on the healthy, in the second, on the diseased side. When the diaphragmatic pleura is affected, there is generally orthopnœa; as might be expected, the respiration is more hurried and difficult during the persistence of the pain.

Anatomical changes.—The first effect of inflammation of the pleura is a diminished secretion, producing dryness of the membrane; and the first visible alteration is redness. Very soon *effusion* comes on, which may be either purely serous, or, occasionally, fibrinous in its character, without serum, constituting the *dry pleurisy* of writers; or most frequently a combination of the two. At first, the fibrinous effusion is in the form of a thin, delicate layer, which soon becomes thicker in spots; of a bloody colour, and occasionally exhibited in the form of shreds, connecting together the two opposite pleural surfaces.

The serous effusion may soon become so considerable as almost to fill the thorax, and to occasion displacement of the viscera; this, however, is rare in the acute stage, though more common in the chronic form. The effusion, if considerable, occasions great compression of the lung, which is found flattened against the posterior walls of the thorax. Should the recovery be rapid, it may happen that all the effusion may disappear by absorption; but generally, adhesions between the opposing pleural surfaces are contracted, which are permanent. This may occur very speedily, if the effusion has consisted exclusively of coagulable lymph; but a longer time is requisite if any serum is interposed. Not unfrequently, *contraction of the walls of the chest* is the result of such adhesions; and long filaments of false membrane are observed stretching between the pulmonary and costal pleura. The fluid portion, moreover, may be retained in little isolated spots, being surrounded with the organized membrane.

In chronic pleurisy, the effused matter may consist, either partially or chiefly, of pus. The quantity of fluid is usually much greater than in the acute stage, and the compression of the lung proportionally decided. *Empyema* is the name given to collections of pus in the cavity of the thorax. The pus sometimes makes its way into the bronchial tubes, producing *pneumo-thorax,* or it may take an external direction.

Physical signs.—The earliest sign of pleurisy, occurring during the first stage, when the membrane is slightly roughened by lymph, is a *rubbing sound* heard during the movements by inspiration, and arising naturally from the friction of the roughened surfaces against each other. This sound is often perceptible to the patient himself. But it ceases as soon as the opposing costal and pulmonary membranes are separated by liquid effusion.

When effusion has occurred, it is denoted by dulness on percussion of the portion of the chest corresponding to the effusion. This dulness, supervening much more rapidly than in ordinary pneumonia, and unaccompanied or preceded by crepitation, generally points out pleuritic effusion. The resonance of the chest is commonly diminished first in the inferior dorsal and lateral regions, corresponding to the base of the lung. As the effusion increases, the dulness of sound gradually extends upwards, and becomes more pronounced. Sometimes the transition from the dull to the healthy sounding parts is so abrupt that a horizontal line will exactly divide them, and this, when well marked, is a very characteristic sign. A change of position will also alter this line in a manner quite distinctive, and, what can happen only in liquid effusion,—the dull sound always accompanies the liquid as it gravitates to the lowest parts. When the effusion is copious, the entire side, from the clavicle down, may be dull. M. Reynaud has pointed out another effect of effusion, which may furnish a diagnostic sign, in its intercepting the slight fremitus or vibration which accompanies the voice in all parts of the chest. The hand applied to a healthy chest readily feels this general vibration; but a layer of liquid, interposed between the lung and the chest, acts as a damper, and prevents the transmission of the vibration.

The respiration is usually heard becoming *bronchial*, as the effusion increases up to a certain point; but then, as the bronchi themselves become pressed by further increase, it becomes faint, and at last ceases.

The *voice* furnishes a valuable sign. If it traverse a thin layer of liquid interposed between the lung and the ribs, it throws it into vibrations, and is itself modified, and rendered sharp and tremulous, resembling the bleating of a goat or lamb. This modification of the voice M. Laennec therefore called *ægophony*. Its most distinctive mark is its tremulous character. This is regarded as a pathognomonic sign of effusion into the pleura, as it can only be produced by this cause.

When the effusion is very considerable from the commencement, or becomes so during the progress of the disease, the ægophony disappears, and the respiration is no longer heard, unless where old adhesions retain some part of the lung near the ribs, and prevent it from being forced back by the effusion. The intercostal spaces become enlarged and elevated; the affected side is more expanded than the sound one, but is no longer influenced by respiration, its immobility

forming a striking contrast with the great mobility of the other, in which the respiratory murmur is increased in intensity, so much so as to assume the "puerile" character. Now, as the sound of this respiration is sometimes heard on the diseased side, through the liquid, it will be necessary to guard against the error of mistaking it for a faint respiration on that side.

Another effect of a large collection of liquid in the chest is to displace the viscera in a remarkable manner. Thus an effusion on the left side will often displace the heart, and make it pulsate under, or even on the right of, the sternum. The liver will be pushed downwards by a large collection of fluid on the right side. These signs are important, because they distinguish this disease from hepatization of the lung, which is liable to be mistaken for pleuritic effusion, but which produces no such displacements.

The absorption of the fluid is indicated by the gradual return of the respiratory murmur: first, in those points where it had persisted latest; afterwards in others; and last of all, in the parts where the accumulation had begun. It is very faint at first, and becomes stronger in time; but, generally, a very long period is required to bring it on a par with that of the healthy side. In other instances, however, the absorption is nearly as rapid as the effusion, and in these cases a returning ægophony (*ægophonia redux*) also announces the diminution. As the absorption proceeds, there is sometimes heard a sound of friction, like that which accompanies the dry stage of pleurisy. This is produced by the approximation and habitual friction of the pleuræ, the surfaces of which are covered with false membranes.

In double pleuritis, where both sides are simultaneously affected, the indications given by percussion are less certain; for both sides sounding equally bad, the standard of comparison is lost. The upper parts of the chest, however, remaining sonorous, with the exact demarcation between these and the line of effusion, will still characterize the disease.

Complications.—Acute pleurisy may be complicated with pneumonia, bronchitis, pericarditis, pneumo-thorax, or peritonitis.

Diagnosis.—Pleurisy may be confounded with pneumonia, pericarditis, and pleurodynia. From the two former it may be distinguished by the difference in their physical signs; from the latter, by the absence of physical signs.

Treatment. —The treatment of pleuritis rests on the same basis as that of peripneumonia. When the patient is of a robust habit, and the inflammation runs high, free *bloodletting* must be employed. As soon as the pain appears, and there is as yet no effusion, *leeches or cups* applied over the painful side, often remove the disease. This effect is obtained with mere certainty if general bloodletting be premised. The combination of both is extremely useful. Large emollient cataplasms should be applied to the affected side. After a full bloodletting, a brisk *cathartic* may be given, so as to act freely on the bowels, and

also produce derivative effects. In most cases, it will now be advisable to bring the system under the influence of *mercury;* and this may be effected in various ways. Some practitioners give blue pill and opium, others prefer calomel and opium; and again, some rely on mercurial inunction. Three grains of calomel, half a grain of opium, and a quarter of a grain of tartar emetic, made into a pill, to be taken every third or fourth hour; or the same proportions of calomel and opium, and one grain of digitalis, instead of the tartar emetic; the pill to be taken in the same way. As long as the fever is high, we should not have recourse to revulsives; but when it is lowered, and no signs of violent reaction are observed, a large blister should be applied to the affected side. The violent symptoms having been subdued, the effusion may be rapidly absorbed, and the sonoriety of the chest be restored. But in most cases the constitutional symptoms and local sufferings only are removed, while the effusion continues stationary, or perhaps even on the increase. It is at this period that, by small local bleedings, repeated counter-irritation, diuretics, and diaphoretics, we can generally succeed in effecting a cure.

In *chronic pleurisy* there is but little constitutional distress: yet the patient emaciates rapidly, the pulse is quick, and the breathing hurried. On examining the chest, one side is found dull and enlarged, the heart is displaced, and the respiration is peurile in the opposite lung.

In such cases, the patient must be confined to bed, his bowels be freely acted upon, and his diet consist of farinaceous substances. A few cups are to be occasionally applied to the affected side, and mild mercurials are to be exhibited, so as to induce slight ptyalism. Counter-irritants are now to be employed. M. Andral recommends, "that the blister to the chest should be replaced either by a seton, the suppuration of which should be kept up for a long time, or by a moxa." As all febrile symptoms subside, we may improve the patient's diet by allowing light broths, fresh eggs, &c.; diuretics should also now be had recourse to. In this stage, Dr. Stokes places great reliance on the internal and external use of iodine. When the absorption of the effused fluid has been effected, change of air should be recommended.

Paracentesis. — If effusion into the pleura is so extensive as to endanger the patient's life from the difficulty of breathing it occasions; or if his health and strength are giving way, it will be proper to make an aperture for the escape of the liquid by *paracentesis.*

EMPHYSEMA OF THE LUNGS.

There are two varieties of this affection; one, in which the dilatation is confined to the air-vesicles; the other, in which the air has escaped from the air-cells into the surrounding cellular tissue, or beneath the surface of the pleura. The name of *vesicular emphysema*

was given to the former by Laennec; the latter may be termed the *extra-vesicular*.

Anatomical characters.—In the *vesicular* variety the lung does not collapse in opening the chest; in consequence of the inelastic condition of the air-cells, the lung is very light and does not crepitate as much as in health; it feels firmer, and does not pit on pressure; its surface is irregular, from the projection of enlarged air-cells. The cells are enlarged, and sometimes several are fused into one, from the rupture of the intervening partitions. It may be confined to a single lobe, or to one lung, though most commonly it affects both lungs. In the *extra-vesicular* form the air which has escaped diffuses itself beneath the pleura in the form of little bladders, which may be pushed about. It may also get into the cellular tissue between the lobes; or if the rupture has occurred at the root of the lung, into the mediastinum; and thence into the cellular tissue of the whole body. Sometimes the pleura gives way, admitting the air into the cavity of the chest, and constituting *pneumo-thorax*.

Symptoms. — Habitual dyspnœa, which, during the earlier periods of the disease, is mitigated in summer, but returns in the winter with increased violence: the complexion is of a dusky hue; the countenance has an anxious and melancholy expression; the nostrils are dilated and thickened; the lower lip is enlarged, and its mucous membrane everted and livid. The movements of the thorax are irregular and habitually unequal; inspiration is short, high, and rapid; but expiration is slow, incomplete, and, as it were, graduated; there is thus a manifest difference in the duration of the two movements. The shoulders are elevated and brought forward, and the patient stoops habitually, a habit contracted in his various fits of orthopnœa and cough; thus, even in bed, we find these patients sitting up, with their arms folded and resting on their knees, and the head bent forwards, the object of which seems to be to relax the abdominal muscles, and to substitute the mechanical support of the arms for that of muscles which would interfere with inspiration. During the fits, the respiration becomes convulsive. There is a constant cough, returning in fits, usually dry, but often attended with the expectoration of a viscid liquid. of a dirty gray colour. This is one of the diseases long confounded under the name of "*asthma.*"

Physical signs. — The chest yields a morbidly clear sound on percussion; it is not, however, tympanitic, as in pneumo-thorax, but may be described as the maximum of true pulmonary sound. This excessive resonance is not given equally at all points, as the disease seldom extends to the whole lung. But although percussion indicates the presence of *air*, the ear applied to the chest detects that the *air is not in motion*, for there is very little or no vesicular breathing. There is heard occasionally some *large crepitation;* this was called by Laennec *dry crepitation*, and he supposed it to be produced, like the crackling of a dry bladder, from the entrance of air to the dilated

vesicles. Dr. Watson, however, believes it to be nothing more than the crepitation of large bubbles of mucus, arising from the catarrh, which is almost always present. Where this disease is extensive, we generally find, owing to long-continued pulmonary obstruction, that the right cavities of the heart are hypertrophied; this latter fact will obviously account for the congested and enlarged state of the liver which also occurs.

The extra-vesicular variety is apt to come on suddenly, from violent inspiratory efforts.

Causes.—Whatever produces violent or long-continued inspiratory efforts may result in a gradual and permanent dilatation of the air-cells. Thus dyspnœa, chronic bronchitis, spasmodic asthma, organic diseases of the heart, tubercles of the lungs, the presence of a tumour on the bronchial tubes, excessive exertions, diving and remaining long under the water, playing on wind instruments, &c.

Treatment. — This disease may exhibit itself under two circumstances: first, it may have existed from infancy, or the causes which produce it may have been present from the earliest period of life; second, it may result, as before stated, from obstructions dependent on bronchitis and the other causes enumerated. Now, in the first case, our treatment avails but little; all we can do is to palliate the symptoms: the mode of treatment in the second case is evident enough. In this disease we must, as in all others, direct our attention to the cause; in fact, we should as soon as possible remove the obstruction of the tubes, and then endeavour to restore the lung to its original condition. Bleeding or cupping may be requisite if bronchitis be present; or counter-irritation by blisters, sinapisms, &c.

The patient should clothe warmly, particularly about the feet, and should live in a sheltered genial situation. He should also take care to avoid all causes of indigestion and flatulency, because, if the action of the diaphragm is impeded, an attack of dyspnœa may be brought on directly. He should, if possible, reside in an equable climate.

The fits of dyspnœa may often be relieved by opium, ether, or Hoffman's anodyne; or if of a more spasmodic character, by a mixture of syrup of seneka, squill, and tincture of lobelia.

PHTHISIS PULMONALIS.

Phthisis pulmonalis, or *pulmonary consumption*, consists in the development in the lungs of a substance called *tubercle*. The peculiar constitution which gives a tendency to the disease is named the *tuberculous diathesis.*

Of tubercle. — Andral describes tubercle, at its origin, as a pale yellow, opaque, round body, of various degrees of consistence, in which no trace of organization or texture can be detected by the naked eye, although the microscope shows various forms of cells, imperfectly developed; so that tubercle evidently consists of unhealthy lymph, whose powers of organization are imperfect.

Seat of tuberculous matter.—The prevailing opinion among pathologists is, that the seat of tuberculous matter is the cellular tissue of organs. It may, however, be formed on secreting surfaces; as, in the mucous follicles of the intestines, on the surface of the pleura and peritoneum, and likewise in false membranes, or other morbid products, and in the blood itself.

Dr. Carswell regards the mucous surfaces as the principal seat of tuberculous matter; and asserts, "that in whatever organ the formation of tuberculous matter takes place, the mucous system, if constituting a part of that organ, is in general either the exclusive seat of this morbid product, or is far more extensively affected with it than any of the other systems or tissues of the same organ." Andral considers the cellular tissue its chief seat, but that it may occasionally occur on mucous and serous surfaces. Lombard supposes it to be restricted to the cellular tissue.

In confirmation of Dr. Carswell's statement, he has shown it in the lungs formed on the secreting surface, and collected within the air-cells and bronchi; in the intestines, in the isolated and aggregated follicles; in the liver, in the biliary ducts and their extremities; in the kidneys, in the infundibula, pelvis, and ureters; in the uterus, in the cavity of that organ and Fallopian tubes; and in the testicle, in the tubuli seminiferi, epididymis, and vas deferens. The formation and subsequent diffusion of tuberculous matter is also observed on the secreting surface of serous membranes, particularly the pleura and peritoneum; and in the numerous minute cavities of the cellular tissue. The accumulation in the lacteals and lymphatics, both before and after they unite to form their respective glands, is frequently very considerable.

Morbid appearances and Pathology.—Tubercles in the lungs in their earliest stage, may present themselves in three forms: 1st. The *common cheesy tubercle*, in yellowish friable masses, in more or less rounded masses, or sometimes filling one or more of the bronchial tubes. 2d. *Miliary tubercles;* small granules, like millet seed, bluish white and semi-transparent, often found in great quantities. Some pathologists consider these as the earliest stage of the yellow cheesy tubercle; others, on the contrary, believe them to be merely some of the air-vesicles solidified by chronic inflammation. But certain it is that they have some relation to the regular tubercle, as they are found in the same person and in the same parts of the lung. 3d. *Tubercular infiltration;* the morbid matter being diffused uniformly through a tissue and not agglomerated in masses.

Tubercle, when deposited, may lie dormant for a long time, without exciting any particular symptoms. In very rare and favourable cases, their softer particles may be absorbed; and nothing be left but the phosphate and carbonate of lime they contained, which may lie quietly in the lung for a whole life. But, in general, tubercle, after a time,

acts as a foreign body, excites inflammation and suppuration in the neighbouring sound parts, and is expelled.

The first visible step is a *softening*, which usually commences in the centre, and gradually advances till the whole is reduced to a soft yellowish mass resembling pus. This increases, till an abscess forms, called a *vomica*.

The vomica enlarges till it bursts into a neighbouring bronchial tube; and then, in *favourable cases*, after the expulsion of the tubercular matter and pus by expectoration, the cavity may contract, become smooth and cartilaginous on its inner surface, and at last be obliterated, and the phthisis be cured.

More generally, however, fresh tubercle is deposited, fresh vomicæ form, and unite, till the patient's lung is riddled with cavities, and he dies exhausted. One or more bronchial tubes are found opening into each vomica.

Tubercle generally occasions some degree of pleurisy and consequent adhesion; this diminishes the frequency of what, nevertheless, happens sometimes, viz., ulceration of the pleura, and escape of the matter from a vomica, and, of course, of air into the pleural cavity; constituting a kind of *pneumo-thorax*, sometimes met with in the last stages of phthisis.

Ulceration of the larynx, tubercular deposits in, and ulceration of the intestinal glands, and a peculiar fatty condition of the liver, are morbid appearances often met with in the phthisical.

Tubercles most frequently are found in the *upper* lobes, and generally at first in the *left* lung.

Symptoms.—It usually commences with a dry, hacking cough, which afterwards becomes mucous. The sputa are at first clear, then opaque, and of a peculiar character, to be noticed presently. The pulse becomes somewhat accelerated, fugitive pains are felt about the chest or in the scapular region, emaciation begins to come on, though the appetite may continue unimpaired. The *emaciation* is the symptom which should especially demand attention. Months may pass by without any particular change in the patient's condition from what has been just described; and usually no apprehension is entertained.

Frequently the first thing that occasions alarm is a hemorrhage from the lungs; or, it may be an attack of pleurisy, which proves very obstinate. This constitutes the *first* stage of the disease. The fever now begins to be somewhat paroxysmal, and is attended with some perspiration at night. These symptoms mark the *softening* of the tubercles. Sometimes the first apparent symptoms are those of bronchitis; and this, as well as the pleurisy already mentioned, may prove both the effect and exciting cause of phthisis.

In the *second* stage, the expectoration changes; instead of the mucous or muco-purulent character previously presented, and which was due to the attendant bronchitis, it now, although still purulent, exhibits lumps of a cheesy matter, whence it is named *mummular*.

This indicates the discharge of the softened tubercle. If the cavity be very large, this sign subsequently ceases, and the expectoration becomes more uniform. Now there is an increase of the fever, which becomes decidedly *hectic*, and which is produced by the constant irritation in a debilitated system. There is no regularity in the chills. Profuse sweats occur at night, during sleep, owing also to debility, and contributing farther to weaken the patient. Occasionally, at this stage, there is hæmoptysis, arising from the opening of some smal vessel by ulceration; this symptom tends to confirm the diagnosis. There may also be occasional attacks of slight intercurrent pleurisy, indicated by sharp pain in the side. The fingernails become curved, and in women the catamenia are suppressed. The symptoms are often ameliorated just at this point, because the softened mass — the source of irritation—has been entirely removed; but in the mean time others are going on to soften. The digestive system now begins to suffer; thirst, loss of appetite, and abdominal pains, torment the patient, and the first indications of the wasting and persistent diarrhœa appear; the patient feels he can lie better on one side than the other, and begins to feel pain in the opposite side of the chest,—a sure sign that his terrible disease has invaded the remaining lung.

In the more advanced, or *third stage*, the debility and emaciation very much increase, the patient is confined to bed, œdema of the feet and legs appear, aphthæ occur in the mouth, and desquamation of the epithelium from the throat, occasioning the sore-throat so often complained of; bed-sores are apt to be formed; the dyspnœa at times is excessive, though generally it is much less than might be expected from the amount of lung involved. If the digestive organs are not implicated, the patient continues cheerful and hopeful to the very end. Death may occur suddenly from hemorrhage from the lungs, or from a sudden congestion of the sound portions; or from pneumo-thorax, or from ulceration of the bowels bringing on peritonitis; or the closing scene may be very gradual and dependent only on the debility.

Hæmoptysis has been often regarded as a *certain* sign of phthisis. But this is an error, since pulmonary hemorrhage may undoubtedly occur as an independent affection, especially in women. In the latter, pregnancy almost always arrests the progress of the disease; but after delivery, it recommences with increased vigour. The explanation of this is that there is an increase in nutrition owing to the presence of the fœtus in utero.

Bronchitis is a necessary accompaniment of phthisis; likewise pneumonia, pleurisy, meningitis, and peritonitis frequently coexist with it.

Physical signs.—It will be remembered that in the condition of the lung in the early stage of the disease there is a deposit of tuberculous matter, usually at the summit. This, of course, must give greater solidity to that portion, and consequently, dulness on percussion, together with great feebleness, if not entire absence, of vesicular re-

spiration. Bronchial respiration will also be heard if a large bronchial tube be enclosed in the solidified portion, and a prolonged sound of *expiration.* Again, as more or less bronchitis necessarily results from the presence of tubercles, we shall have likewise the physical signs of that disease, as the moist and dry rhonchi. Inspection of the chest often exhibits a marked depression under the clavicle of the affected side, arising either from the shrinking of the lung from consolidation, or from intercurrent pleurisy.

The sounds of the voice and heart are conveyed with greater loudness through the solidified structure; hence *bronchophony* is frequently heard.

As the period of softening approaches, the indications of air passing through a fluid, or passing in and out of a cavity, are afforded. First, supposing the vomica to be half filled with liquid, and to communicate freely with the air-tubes, there will naturally be heard on every entrance and exit of air, a *gurgling* sound, like the bursting of very large bubbles. The same may also arise from dilatation of the bronchi, or from abscess of the lung; but these conditions, and especially the last, are rare.

If the vomica is empty, there will be heard a class of sounds called *cavernous respirations;* consisting of certain variable sounds indicating the passing of air into and out of a cavity.

If the vomica be partially full of liquid, the latter may perhaps be heard to splash, when the patient coughs.

The particular resonance of the voice which constitutes *pectoriloquy,* is another sign of a vomica. When a cavity of moderate size and regular form, empty, or nearly so, is in free communication with a large bronchial tube, and is very near the surface of the lung in contact with the thoracic parietes, or when the intervening structure is rendered a good conductor by condensation, the voice is transmitted in the most perfect and unmodified manner, and seems to be produced in that spot of the chest, seemingly distinct from the oral voice. This is *perfect pectoriloquy.* If heard with the stethoscope, the sound of the voice seems to come through the tube, and enters the observer's ear louder than that which, coming from the patient's mouth, strikes the other ear; but the utterance is never so distinct. When heard to this degree in parts where there is naturally little or no resonance of the voice, it proves beyond doubt the existence of a cavity communicating with the bronchi.

By *imperfect pectoriloquy* is meant that form in which the voice does not seem to enter the stethoscope, but only to resound at the end. This sign cannot be relied upon when heard in the sternal half of the infraclavian and mammary regions, the axillæ, and interscapular spaces.

There is yet another class of sounds to be spoken of. It was said before, that the pleura sometimes ulcerates, so that a communication is formed between a vomica and the pleural cavity. In consequence

of this aperture, air passes at each inspiration into the pleural cavity whilst the lung collapses; and more or less liquid will also escape from the vomicæ. The spot where this perforation occurs, is generally, says Dr. Watson, opposite to the angle of the third or fourth rib. The indications of this state of things will be, 1st, great clearness on percussion; 2d, complete absence of respiratory murmur; 3d, a peculiar resonance of the voice, breathing, and cough, called by the French *amphoric resonance.* This is a sound of metallic character, and greatly resembles that produced by speaking or coughing over an empty barrel or copper boiler, or by blowing into an empty bottle; 4thly, there is occasionally a tinkling sound of a metallic character, produced by the fall of a drop of liquid from the upper to the lower part of the cavity.

Now, these four sounds, all indicating, as they do, the existence of a large cavity containing air and liquid, and communicating with the trachea, are generally caused by pneumo-thorax, as before said. But they may also, though very rarely, be caused by the presence of a very large vomica. In this case they will only be heard in the upper part of the chest, and instead of great clearness, there will be extreme dulness on percussion.

Another mode of physical exploration is by the use of the *spirometer*, by means of which the *vital capacity* of the chest is ascertained. This has been already described in the Physiology, under the head of RESPIRATION.

Of the sputum. — In pulmonary consumption, there is no constant relation between the appearances of the expectorated matter and the state of the lung. In many cases, it is not at all characteristic; indeed, it may be mucous while large cavities exist in the lung, or purulent from bronchial irritation. Dr. Forbes observes — "In the earliest stage of the disease, the cough is either quite dry, or attended by a mere watery or slightly viscid, frothy, and colourless fluid; this, on the approach of the second stage, gradually changes into an opaque, greenish, thicker fluid, intermixed with small lines or fine streaks, of a yellow colour. At this period, also, the sputa are intermixed with small specks of a dead white or slightly yellow colour, varying from the size of a pin's head to that of a grain of rice, and which have been compared by Bayle to this grain when boiled. These have been noticed by many writers, from Hippocrates downwards. After the complete evacuation of the tubercles, the expectoration puts on various forms of purulency, but frequently assumes one particular character, which has always appeared pathognomonic of phthisis, although the more accurate and extensive observation of modern pathologists has proved the same to exist occasionally in simple catarrh. The expectoration alluded to, consists of a series of globular masses, of a whitish-yellow colour, with a rugged woolly surface, and somewhat like little rolled balls of cotton or wool. These commonly, but not always, sink in water. This kind of expectoration has appeared most common in

young subjects, of a strongly-marked strumous habit, and in whom the disease was hereditary. At other times, in the cases in which these globular masses are observed, and also in those in which they have not appeared, the expectoration puts on the common characters of the pus of an abscess, constituting a uniform, smooth, coherent, or diffluent mass, of a greenish, or rather grayish hue, with an occasional tinge of red (from intermixed blood), and sometimes more or less fœtid." Dr. Stokes considers the expectoration, in which the globular ragged masses here described are expelled, more peculiarly allied to phthisis than any other. He also adds, "I do not recollect a single case in which I observed this character, that did not turn out to be phthisis."

Course.—The ordinary course of phthisis is slow, from one to two years; it may even be much more protracted. But sometimes it is very rapid, terminating in six or eight weeks. Such cases are termed *acute phthisis*, or *galloping consumption*; they usually depend upon an excessive deposit of *miliary* tubercles throughout the lungs.

Prognosis and Treatment.—Phthisis unfortunately generally proves fatal, though by no means universally so; proofs of its occasional curability are afforded in the cicatrices found in the lungs, in persons who have afterwards died of other diseases. The chances of cure depend upon the quantity of the tubercle deposited, and upon the tendency in the constitution to deposit more. No *medicine* can cause its removal, but the system can be supported until nature accomplishes this; and the tendency to farther deposition may often be obviated. Hence, the main point in the treatment is *a proper hygiene*. The process of nutrition should be invigorated up to the healthy standard, but not beyond this. The food should therefore be nutritious, and easy of digestion; stimulation should, as a general rule, be avoided, although in some cases the moderate use of wine, or the malt liquors, may be allowed. *Exercise* is specially important. This should be taken as much as possible in the open air, on foot, or still better on horseback. It should be steady and habitual, and the patient should not be kept within doors, even in cloudy weather, provided only he is warmly clothed. This last is a point of great importance, and is too commonly neglected. A residence in a warm, dry climate, especially during the winter season, is always desirable; and the inhalation of the air from a pine forest is by some deemed beneficial.

The medicinal agents are—tonics, if the digestion is enfeebled, particularly the cold infusion of wild cherry bark; iron and iodine, if there is anemia; but the most important of all is cod-liver oil. This last article may be given in doses of a tablespoonful three times a day, for adults, or even less if the stomach is delicate; its use should be persevered in for at least six or eight weeks, before which time no benefit need usually be expected. In the early stages of the disease it has produced very decided effects, appearing wonderfully to increase the powers of nutrition; and, even in the advanced stages of the dis-

order, it not unfrequently stays its progress, and renders the patient more comfortable.

Another principle in the treatment, to be borne in mind, is not to deplete, nor to mercurialize, to the same extent as in other diseases. All exciting causes should be sedulously avoided, as improper exposure to cold. Care should also be taken not to repel old cutaneous eruptions, or lymphatic inflammations or ulcers; nor to heal up a fistula in ano, or hemorrhoids, by external means.

The *effects* of phthisis also demand attention. The *cough* is best quieted by morphia, in the syrup of Tolu, or by hyoscyamus; the *bronchitis* by inhalation of the vapour of tar or iodine. *Hæmoptysis*, if slight, may be let alone; if more violent, it may be treated by the usual means, avoiding bleeding, at least to any extent; *night-sweats* by mineral acids, and the infusion of Prunus Virginiana. The *hectic fever* is sometimes benefited by moderate doses of quinine. The *diarrhœa*, if exhausting, must be checked by opiates and astringents, or by an opiate enema. The debility which marks the closing period of the disease demands the usual stimulants. The "sugar-house cure" probably depends as much on the saccharine diet used, as on the atmospheric influences.[1]

The *prophylactic* treatment is all-important. In an individual inheriting a tuberculous diathesis, a plan of hygienic treatment should be adopted from the earliest period of life, and rigidly carried out. This should mainly consist in abundant out-door occupation or exercise, and the avoidance of sedentary habits; together with a nutritious, wholesome diet, and agreeable associations.

SECTION III.

DISEASES OF THE CIRCULATORY ORGANS.

DISEASES OF THE HEART AND ITS MEMBRANES.

Auscultation of the heart in health.—On applying the ear to the region of the heart in a healthy person, a sound is heard at each pulsation, followed by an interval of silence. This sound is double, consisting of a dull slow sound, immediately followed by a short quick one. The first sound is produced by the contraction (systole) of the ventricles, and is synchronous with the pulse of arteries near the heart. The second, or short one, accompanies the dilatation (diastole) of the ventricles. This second sound is said to be produced by the shock caused by the tightening of the semilunar valves at the ventricular diastole. Laennec rates the relative duration of these sounds to be as follows—The first sound, two-fourths; the second sound, one-fourth, or a little more; the interval of silence, one-fourth, or a little less. These sounds

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[1] Dixon's Elements of Medicine. Philadelphia, 1855, p. 626.

are naturally most distinct in the space between the cartilages of the fourth and seventh ribs of the left side, and on the lower part of the sternum; the former part corresponding with the left, and the latter with the right side of the heart. Simultaneously with the first, or systolic sound, an impulse or shock is communicated to the stethoscope. It is most perceptible at and between the cartilages of the fifth and sixth ribs, where it may be felt by the hand; but the stethoscope commonly renders it sensible in lean persons over the whole præcordia. Considerable variety in the force of the impulse may occur from various extraneous causes acting on a healthy heart. Thus, the pressure of tumours behind it, flatulent distension of the stomach, great enlargement of the liver and spleen, contraction of the chest from pleurisy, deformity of the spine, and similar causes, which have the effect of pushing the heart into closer contact with the anterior walls of the chest, will make its impulse against them stronger. Again, extensive effusions of air or liquid in the left pleura may displace the heart, so that its impulse can only be felt under or even to the right of the sternum. The action of the heart is naturally accelerated by exercise, stimulating drinks, heat, &c.; and this excited action is attended with an increased impulse and with louder sounds.

Exact position of the heart. — "A line," says Dr. Hope, "drawn from the inferior margins of the third ribs, across the sternum, passes over the pulmonic valves a little to the left of the mesial line, and those of the aorta are behind them, but almost half an inch lower down. A vertical line coinciding with the left margin of the sternum has about one-third of the heart, consisting of the upper portion of the right ventricle on the right, and two-thirds, composed of the lower portion of the right ventricle, and the whole of the left, on the left. The apex beats between the cartilages of the fifth and sixth left ribs, at a point about two inches below the nipple, and an inch on its sternal side."

"Take the fifth costal cartilage on the left side," says Dr. Latham, "and let a point midway between its junction with the sternum and its junction with the rib be the centre of a circle, two inches in diameter. This circle will, as nearly as possible, define the space of the præcordial region, which is naturally less resonant than the rest."

Relation of the sounds to the state of the heart.—"A clearer sound," says Dr. Latham, "proceeds from a thin heart; and a duller sound from a thick heart; a sound of greater extent from a large heart, and a sound of less extent from a small heart. A more forcible impulse is given by a thick heart, and a feeble impulse by a thin one; the impulse is conveyed to a longer distance from a large heart, and to a shorter distance from a small heart." [1]

"Sounds and impulses," continues Dr. Latham, "are the interpreters of each other. The true meaning of the sound is tested by the

[1] Lectures on Diseases of the Heart, vol. i, p. 18.

impulse, and the true meaning of the impulse is tested by the sound. Thus, from a clearer sound, we argue only the probability of an attenuated heart, but we argue its certainty from a clearer sound, joined with a weaker impulse. From a stronger impulse we argue only the probability of a hypertrophied heart; but we argue its certainty from a stronger impulse joined with a diminished sound. When impulse and sound increase together, there is probably no hypertrophy, but the heart is only acting more forcibly from pure excess of nervous energy. When impulse and sound decrease together, there is probably no atrophy, but the heart is only acting more feebly from pure defect of nervous energy. When the sounds and impulse of the heart are both perceived beyond the præcordial region, they give notice (generally speaking) of dilatation of one or other of the ventricles. If, under these circumstances, sound predominates over impulse, then with dilatation there is either attenuation, or somewhat less than a proportionate increase of its muscular substance. If impulse predominate over sound, with dilatation, there is either hypertrophy, or somewhat more than a proportionate increase of its muscular substance."

Morbid sounds of the heart.—Unnatural sounds may be called *murmurs;* and they are of two kinds: the *exocardial*, produced *external* to the heart, that is to say, *in the pericardium;* and the *endocardial*, produced in the heart itself.

The *endocardial* murmurs have a *blowing* character, the *exocardial* give the idea of friction.

"The endocardial murmur," says Dr. Latham, "is not only different in kind from the natural sounds of the heart, but it takes their place, and is heard in their stead. It comes exactly where the first sound, or where the second, or where both sounds should be. It keeps strict time with the systole or with the diastole of the heart, or with both.

"The exocardial murmur, too, is different in kind from the natural sounds of the heart. But it does not take the place of them; it is not heard in their stead. In proportion as it is louder, it obscures or overpowers the natural sounds. But the natural sounds are still apt to reach the ear through the exocardial murmur; and when they do not reach the ear, it is because they are imperceptible under the circumstances, not because they cease to exist."

Endocardial murmurs (i. e., murmurs *within* the heart) are caused by peculiar *vibrations of the columns of blood* which pass through the heart; and these vibrations may depend,—1st, upon an unnaturally thin *quality*, and deficient quantity *of the blood*, as in the murmurs heard after hemorrhage; 2dly, *on diseases of the valvular orifices* of the heart, offering obstacles to the passage of the blood.

A murmur caused by the passage of the blood through a diseased valvular orifice may be *direct* or *regurgitant;* that is, may be produced during the flow of the blood along its natural channel, if contracted;

or during its regurgitation, which will happen if the diseased valve is unable to shut properly.

In order to ascertain what valve is diseased, notice must be taken of the *time* at which the murmur is heard—of the *part* of the præcordial space *where it is heard most loudly;* and of the *direction in which it is conveyed the farthest.*

Valvular disease of the right side of the heart is very rare indeed; and the diagnosis of it from disease on the left side is a matter of some uncertainty. The following observations, therefore, chiefly apply to the aortic and mitral valves.

When a single endocardial murmur is heard during the *systole* of the heart, its seat is most probably the aortic valve, which is thickened so as to impede the blood in its exit from the heart and to throw it into vibration.

When a single murmur is heard, coincident with the heart's *diastole,* this also may be produced by a diseased aortic valve, if so diseased as to be incapable of closing, and permit the blood to *regurgitate* into the ventricle.

When there is a double murmur, both *systolic* and *diastolic,* these also may arise from disease of the aortic orifice alone; the former being a murmur caused by the flow of blood from the heart; the latter by its regurgigation.

Again, when there is a *single systolic murmur,* it may be caused by disease of the *mitral valve,* permitting the blood to regurgitate into the left auricle from the ventricle, when the latter contracts.

The spot where all endocardial murmurs are heard most distinctly, is immediately over the valve which originates them. And the space under which the cardiac valves lie, may be said to be comprised *between the lower margin of the third left costal cartilage and the lower margin of the fourth;* extending inwards to the middle of the sternum. Here it is that almost all murmurs are heard most clearly.

The method of distinguishing them from each other is based on the fact that the murmur will be conveyed along the direction of the column of fluid whose vibration causes it.

Thus if a murmur be seated at the aortic valve, it will be heard most clearly *over the left half of the sternum, between the third and fourth costal cartilages.* But the sound will also be conveyed with tolerable clearness *in the course of the aorta and its branches;* that is to say, upwards and between the second and third ribs of the *right side,*—perhaps it will also be heard in the carotids.

If the disease (which is very rare) were seated in the *pulmonic valves,* the murmur would follow the course of the *pulmonary artery,* upwards between the second and third ribs of the left side.

If it were seated in the *mitral valve,* the murmur would be lost if the stethoscope were moved upwards; but would still be heard distinctly if it were moved *downwards towards the apex of the heart.*

If the murmur is heard plainly in *both directions*, then *both aortic and mitral valves* are probably diseased.

There are some few circumstances which must be taken into account in estimating the value of endocardial murmurs as signs of valvular disease.

For first, they are sometimes absent altogether when the patient is in repose; although they may be excited by causing the patient to move about, so that the heart may beat more forcibly.

Secondly, the loudness of the sound is by no means a measure of the extent of the disease; for in long-standing cases, where a diseased orifice has become very contracted, the sound often becomes very feeble indeed.

Thirdly, very violent action of the heart alone, without valvular disease, may occasion a murmur; this often happens to children; seldom to adults.

Fourthly, if the heart is embarrassed by deformity of the chest, or if it is too much pressed upon by the stethoscope, murmurs may be created.

Fifthly, in cases of anæmia, after hemorrhages, or when the blood has become pale and watery through ill health, there will be a loud systolic murmur, conveyed along all the arteries; and also often accompanied by a continuous humming noise heard in the veins, especially the internal jugular. This state is to be remedied by nourishing food and tonics.

Lastly, the sounds of respiration may imitate cardiac murmurs so closely, that it may be necessary to make the patient hold his breath, to distinguish their real source.

INFLAMMATION OF THE HEART—ENDOCARDITIS, AND PERICARDITIS.

These maladies are generally found to be concomitants of *rheumatism*. No doubt they do often occur from other causes; and they often occur, too, in slight degrees without being complained of or suspected.

Symptoms.—The symptoms of endocarditis, are, 1st, *pain* in the heart; 2d, *disordered action* of the heart, which may be violent, or else feeble, irregular, and intermitting; 3dly, some dyspnœa; and, lastly, *abnormal sounds;* beginning with a *roughness* and afterwards, a murmur, termed the *bellows murmur*, arising from thickening of, or deposit on some of the valves. One or more of these symptoms, occurring in the course of acute rheumatism, may be considered a sign of endocarditis.

The pain is sometimes so slight that the patient scarcely notices it, if at all; but in dangerous cases is an extreme anguish, liable to be followed by orthopnœa, restlessness, delirium, and death. The murmur sometimes is heard at the very beginning, whilst there is no other

symptom or complaint about the heart; sometimes it does not come on till the middle or end of the disease.

The symptoms of *pericarditis* are, 1st, pain in the region of the heart, augmented by pressure and by a deep inspiration; 2dly, irregular or violent action of the heart; 3dly, difficulty of breathing; and, lastly, the *physical signs*—an *exocardial murmur*, caused by the rubbing of the roughened and inflamed serous surfaces of the heart and pericardium against each other; dulness of percussion over an unusually large space of the præcordial region; and sometimes a distinct undulation visible between the cartilages of the 2d, 3d, and 4th left ribs. The exocardial murmur resembles the rubbing of two rough surfaces against each other—it is called by Dr. Watson the *to and fro sound;* which name well expresses its character. The dulness on percussion, and the undulation, arise from the presence of fluid effusion in the pericardium.

The friction sound ceases of course if the heart and pericardium become adherent together.

Inflammation of the heart is sometimes attended with so much nervous and cerebral irritation, as to mislead the practitioner, unless very cautious, and induce him to look at the head instead of the præcordia.

Pericarditis, like endocarditis, may come on in the course of acute rheumatism, without being denoted by pain, or any symptom sensible to the patient. The region of the heart should therefore be frequently scrutinized by the stethoscope in rheumatism, and proper measures be adopted as soon as there is the first indication of murmur.

Frequency of the disease.—Dr. Latham shows that the heart is much more frequently inflamed in acute rheumatism than is often imagined. Out of 136 cases of that disease, the heart was inflamed in 90, about two-thirds; of these 90 cases there were 63 of endocarditis; 7 of pericarditis; 11 of endocarditis and pericarditis combined, and 9 in which the seat was doubtful.

Out of this number there were but three deaths; but yet in the great majority of those who recovered, there was some deviation from the healthy state remaining, which, no doubt, laid the foundation of subsequent chronic disease of the valves.

Morbid appearances in acute pericarditis.—The membrane intensely red; perhaps ecchymosed, its cavity containing serum with flakes of lymph; and both the inside of the pericardium and the outside of the heart covered with a layer of lymph of variable thickness; sometimes the opposing surfaces adhere; sometimes they are free, and the lymph is flocculent, or corrugated, making the heart's surface look like tripe.

Of endocarditis.—The affected portion of the valves is generally round thickened, pink, and fringed with deposits of lymph.

Treatment.—The treatment of inflammation of the heart is the same as that of acute rheumatism, only modified to meet the emer-

gency. *Bleeding* must be employed, if the general state of strength and excitement show it to be demanded, and that it can be borne; *cupping between the shoulders*, or *leeches to the præcordia*, are indispensable. After free depletion, *digitalis* should be given to quiet the heart's action. Full doses of *opium*, at bedtime, to insure sleep; and *calomel*, with smaller doses of opium, in such quantities as the severity of the disease may demand during the day; *purgatives*, so as to clear out the abdominal viscera, and *colchicum* are the main remedies. And it should be observed that it will be right to leech or cup the instant any abnormal sound is heard in the region of the heart, although no symptom of uneasiness there may be complained of by the patient. When the acute state has subsided, *blisters* will hasten the absorption of effusion or deposit of lymph, which may be farther insured by using a combination of calomel, squill, and digitalis, or nitrate of potassa, or cream of tartar.

CHRONIC VALVULAR DISEASE.

This is a frequent result of chronic endocarditis. The valves of the left side are most subject to it. They may be either contracted or distorted, preventing accurate closure; or ulceration may occur through the valves. Two other morbid changes are also noticed,—*vegetations* or roughened projections, and an *atheromatous deposit* under the tissue of the valves, similar to what occurs in the arteries; the surface over this deposit is liable to ulcerate. Occasionally there is a deposition of cartilaginous or osseous matter; and in gouty subjects, of the urate of soda. Sometimes the valves become atrophied.

Effects.—If the disease is very slight but little difficulty ensues; but if severe, it is apt to produce hypertrophy and dilatation, dropsy, local inflammations, and ultimately death. These results are owing, first, to an impediment to the forward movement of the blood in consequence of the contracted valvular opening, and secondly, to the regurgitation of the blood, producing an accumulation behind. Suppose the left auriculo-ventricular (mitral) valve to be affected: if its orifice is contracted, the blood, being impeded in its course, accumulates in the left auricle, and distends it; congestion of the pulmonary veins is the consequence; the lungs share in this congestion, and pulmonary apoplexy may be the result. This must, of course, occasion an insufficient supply of blood to the general system, to relieve which, the heart must make greater efforts; and thus hypertrophy may follow. Again, suppose some insufficiency in the mitral valve, owing to ulceration, for example, the blood will regurgitate into the left auricle at each pulsation, producing, as before, congestion of the auricle and lungs, and hypertrophy of the heart.

In contraction of the *semilunar valves of the aorta*, a less supply of blood is sent to the general system, but congestion and consequent hypertrophy, and also dilatation of the left ventricle may occur. If these valves be imperfect through ulceration or adhesion, the regurgitation

into the ventricle produces hypertrophy and dilatation, with a full, *jerking* pulse.

General symptoms.—Dyspnœa, increased by muscular efforts, or emotion; palpitations, also increased by the same causes; the pulse often intermittent, jerking; at other times, very frequent, small, and irregular.

Physical signs.—The pathological sounds are termed *murmurs.* It is very important to distinguish between the murmurs of functional and organic disease. In *mitral contraction,* the murmur must accompany the second sound, because occurring during the diastole of the ventricle, and the passage of the blood from the auricle into the ventricle. It is heard over the ventricles, between the fourth and fifth ribs,—rather than *immediately* over the valves, because the lung here interferes. It is never heard *above* this point,—which will distinguish it from aortic valvular deficiency. Another point to be remembered is, that the second sound of the heart is also distinctly heard, showing that the aortic valves are sound.

In *mitral deficiency,* the abnormal sound will accompany the ventricular contraction, and will hence be heard accompanying the *first* sound. It is a loud and prolonged murmur in a low key, like whispering the word "who;" it is the most common of the abnormal sounds, and is heard over the seat of greatest dulness.

In *contraction of the aortic valves,* the murmur accompanies the first sound, and is heard over the third rib, and upwards and to the right of the sternum, in the course of the aortic arch. It is comparatively superficial, and sounds like whispering the letter "z."

In *aortic regurgitation,* the murmur accompanies the second sound, and is heard near the apex of the heart, because produced by the blood rushing down into the left ventricle, through contraction of the aorta. It is superficial, and not very strong, and is likewise heard high up in the course of the aortic arch. In slight aortic regurgitation there is only a blurred second sound.

In valvular disease of the *right* side, the sounds are much the same as those of the left side. The *tricuspid* murmurs are heard at the right of the sternum; those of the *pulmonary semilunar valves* are superficial, and on the *left* of the sternum.

Treatment.—If taken early, it may be cured. If it is the result of inflammation, the proper plan would be a long-continued but moderate use of mercury, so as not to affect the gums. Iodine may also be cautiously employed, either alone, or in conjunction with mercury. If it can be traced to a rheumatic or gouty diathesis, a protracted use of the alkalies, with colchicum, is indicated. Counter-irritation by means of cups repeated, or blisters, or pustulation, will also be serviceable.

HYPERTROPHY AND DILATATION.

The dimensions of the heart may be increased, either by augmenta-

tion of its muscular walls, or enlargement of its cavities. The name *hypertrophy* is given to the former of these conditions, when resulting from an increase of its muscular substance; that of *dilatation* to the latter. Both conditions are apt to coexist.

The average size of the healthy heart is usually described as about that of the individual's fist; the thickness of the left ventricle, four to six lines; that of the right, two to three lines; that of the left auricle, about one and a half lines; that of the right auricle, about one line. The *cavities* are very nearly of equal size, and are capable of containing, each, about two fluid ounces.

Sometimes all the cavities are enlarged, changing both its shape and position. Again, only one cavity may be hypertrophied, in which case the other will resemble a small appendix. The columnæ carneæ are also generally enlarged at the same time. It is rare to witness dilatation of all the cavities; the ventricles are more liable to it than the auricles.

Several varieties of hypertrophy are usually described, viz.,—*simple hypertrophy*, in which the muscular parietes are thickened, but the cavities unaltered in size; *hypertropny, with dilatation*, or *eccentric hypertrophy*, in which there is also an increase of the capacity of the cavities; and *concentric hypertrophy*, in which the substance of the heart is thickened, and its cavities diminished.

Modern pathologists have decided that the *concentric hypertrophy* is a pathological mistake; that, in fact, it depends on the state of contraction in which the heart happens to be left at the moment of death; and that the so-called concentric hypertrophy often vanishes as the *rigor mortis* goes off, and the heart dilates and becomes flabby.

General symptoms.—One of the most prominent is dyspnœa, produced by any exertion; also, palpitations, which are sometimes so violent as to shake the whole body; præcordial uneasiness. The *secondary* signs are, violent headache, vertigo, buzzing in the ears, flashes of light, pulmonary congestion, pneumonia, apoplexy of the lungs, congestion of the liver, bilious disorders, and dyspepsia, and finally, general and local dropsy. Towards the close, the patient's suffering is extreme; unable to lie in bed, he is forced to assume constantly a sitting posture, with the body bent forward. Death sometimes occurs very suddenly in syncope.

Hypertrophy of the left ventricle may be caused, *first*, by circumstances that excite the action of the organ to a great degree; such as high living, violent exercise, and mental excitement; and, *secondly*, by obstructions of the mouth of the aorta. These, of course, require greater muscular force to be exerted in order that the blood may be propelled in the same time through a small aperture as through one of the natural size.

Hypertrophy with dilatation is much more common under the last-mentioned circumstances, than simple hypertrophy; for the same cause that obstructs the current of blood, will also give the cavity a tendency

to dilate, especially if the patient has but little tone and vigour in the muscular system.

The symptoms are, a very strong and full pulse, all the functions are for a time invigorated, flushed face, prominent eyes, headache, tendency to apoplexy. If there be, at the same time, mitral regurgitation, the pulse will be softer, and there will be the valvular murmur.

Hypertrophy of the right ventricle is not accompanied by a similar pulse. It is generally attended with tricuspid regurgitation, which produces a pulsation in the jugular veins.

The impulse is stronger and more extensive; the first sound is duller than usual. Percussion is duller; and often there is greater prominence in the præcordial region.

Dilatation without hypertrophy.—This is a kind of muscular atrophy, and happens to flabby cachectic patients, in whom the heart gives way and stretches in efforts to carry on the circulation.

The signs of dilatation are such as arise from a want of duly aerated blood in the different parts of the body; such as pale face, purplish lips, feeble pulse, general paleness of the surface, œdema of the feet, the movements of the heart feeble and prolonged, great disposition to faintness, and tendency to passive hemorrhage and dyspnœa on the slightest excitement.

The *sounds* are clearer than natural, accompanied by dulness on percussion, and a feeble pulsation.

Causes.—Valvular disease is the most frequent cause; rheumatic irritation, any cause producing constant and excessive exertion of the organ, as violent exercise, playing on wind-instruments, violent passions, intemperance in eating and drinking, emphysema of the lungs, asthma; anemia predisposes to it by occasioning relaxation.

Treatment.—It is curable if the valves are not implicated, and if taken in the early stage. The great point is to remove the exciting cause, especially valvular disease. Regulate the patient's habits of life and occupation; moderate his diet; occasional *moderate* bleedings in hypertrophy; with an active pulse, or cupping, if there is pain; but avoid large bleedings; occasional saline cathartics; *passive* exercise. *Digitalis* is the special medicine; prussic acid is also used for the same purpose; tincture of aconite and colchicum, where it has resulted from rheumatism; constant revulsion to the surface.

In *dilatation*, the object is to produce good blood; hence bleeding should be avoided; tonics, iron, cod-liver oil, and animal food should be directed, with an occasional small dose of a saline cathartic. Digitalis is here specially required. The wild-cherry bark is an excellent tonic; and as nervous symptoms are very apt to be present in females, opium, belladonna, valerian, &c., may be given with advantage.

Various other organic diseases of the heart are occasionally witnessed, but as they are comparatively rare, and for the most part incurable, it will suffice barely to mention them here.

Atrophy occasionally occurs. *Softening* may take place without

inflammation; it may result in a rupture of the heart. Various *indurations* of the heart may occur, as of the *fibrous, cartilaginous*, and *osseous* character. *Fatty degeneration* is a rare disease. *Tubercle, carcinoma*, and *polypi* are also rarely noticed.

ANGINA PECTORIS.

This dreadful complaint attacks persons who have some organic alteration of the heart, and generally of an atrophic character. In some cases the heart has been found excessively loaded with fat; in others there has been a softness of the heart; in others disease of the valves or of the aorta; and in several *ossification of the coronary artery*, a change which would, of course, greatly interfere with the proper nourishment of the heart.

Symptoms.—These seem to be of the nature of a *cramp*, or *spasm of the heart*, combined with inability to propel its contents properly. The patient, in walking briskly, especially if he does so after a meal, is seized with a peculiar pain in the region of the heart. It is a pain of an alarming nature to the patient, who often feels that he must stop and support himself, and as if another step would be fatal. The pain goes through to the back, and often shoots down to the elbow of the left arm. The pulse sometimes stops during the paroxysm. When it has lasted some seconds, it goes off.

The attacks, generally, as the disease advances, become more and more frequent and violent, and more easily induced.

Treatment.—This may be comprised in the word *quiet.* The patient should be warned of his danger; and the means which have been before spoken of should be employed to allay irritation of the diseased organ, taking care neither to weaken the patient too much on the one hand, nor on the other to let his veins become too full, or the liver and kidneys inactive.

FUNCTIONAL DISEASES OF THE HEART.

These are exhibited under two main forms,—*palpitations* and *neuralgic pains.*

The symptoms often strongly resemble those of organic disease, such as dyspnœa, pain, &c.; but the characteristic distinction is *the want of a constant murmur* in merely functional disorder.

The *causes* are such as produce general nervous derangement, as the excessive use of tobacco, or of coffee and tea, dyspepsia, flatulence, hysteria, severe study, depressing emotions, sexual excesses, and anemia. They are most apt to occur about puberty, or a little after; and in females more than in males.

The *treatment* is to be conducted on general principles,—removing all known causes, and employment of tonics, chalybeates, antispasmodics, and exercise.

DISEASES OF THE BLOOD-VESSELS.

ARTERITIS.

Inflammation of the arteries is rare in the acute form. The symptoms are pain and tenderness along the course of the vessel, attended with a thrill or throbbing. Coagulable lymph is effused within the vessel, often producing a complete arrest of the circulation, and resulting in gangrene. It is highly probable that many cases of spon taneous gangrene in old people are thus produced.

Chronic arteritis is probably more common; but is not usually discoverable before death. Atheromatous deposits may occur in the coats of the arteries, exciting ulceration. They are also liable to *ossification* as age advances.

The *treatment* consists in bleeding, leeching to the part affected, blisters, and fomentations.

PHLEBITIS.

Inflammation of the veins is of frequent occurrence. The signs are pain and tenderness in the course of the vessel, which soon becomes cord-like and knotted, by which it may be distinguished from arteritis. There are swelling and redness of the adjacent parts — the redness being in streaks. The limb below the part affected is swollen, from obstruction of the circulation and effusion of serum. A similar condition is seen in the *milk leg* of women, depending upon inflammation of the uterine veins, and extending thence to the iliacs and femorals. A frequent effect of phlebitis is the production of pus, in which case either perfect occlusion of the vein *above* occurs, with the formation of an abscess, or the pus passes into the heart, and produces excessive prostration. Another consequence is *metastatic abscess*, arising from the deposit of pus in some particular part. It is possible that the pus, which enters the circulation, may act as a *ferment.*

The *treatment* consists in free leeching, blisters, lead-water applications, fomentations, &c.; and, in suppuration, a supporting plan.

DISEASES OF THE BLOOD.

SCORBUTUS, OR SCURVY.

This disease consists in a peculiar depraved state of the blood, the nature of which is not known.

It commences with a feeling of languor, or general debility and mental despondency; a sense of fatigue is experienced on the slightest exertion; the face is either pale or sallow, and presents an appearance of puffiness; the gums are swollen, soft, and of a purplish colour, and bleed easily; the breath becomes offensive, and petechiæ appear over the body. Hemorrhage frequently occurs from mucous surfaces; the feet become œdematous; hard and painful swellings occur over the surface; a disposition is evinced to inflammation of the viscera of a

low grade; and also to hemorrhagic effusions. The tongue and appetite often continue unaffected. Death is produced either by the debility or hemorrhage,—the intellect remaining sound to the last.

Causes. — The chief cause is the deprivation of proper vegetable food. Other causes may contribute, such as long-continued exposure, fatigue, the depressing passions, &c. The exclusion of fresh vegetable food will not produce it, provided *fresh* animal food can be procured. It occurs most frequently on board of ships, on long voyages, and occasionally, also, on land, under similar circumstances.

Treatment.—This is very simple; all that is requisite is to remove the cause, by giving plenty of *fresh* vegetable food and acids, especially lemon juice or citric acid. Cabbage and potatoes are also excellent antiscorbutics; and milk is a good article of diet. Of medicines, nitrate of potassa has been specially recommended; but it should be remembered, that nothing will avail in the absence of vegetable food.

PURPURA.

This consists in the production of livid or purplish spots, generally commencing at the lower extremities. Two varieties are described—*purpura simplex* and *p. hemorrhagica*, although it is probable they do not essentially differ; in the latter, there is also effusion of blood into the mucous membranes.

Sometimes there are constitutional symptoms, as in scurvy, especially neuralgic pains in the back. It appears often in successive crops; the spots being usually small, but at times becoming very large, by increase of the effusion. Occasionally it is periodical. It is not elevated, nor is it accompanied by any sensations. It is simply an effusion of the colouring-matter of the blood.

In p. hemorrhagica the blood escapes from the gums, lungs, &c.

Causes. — Not well understood. It occurs in depraved constitutions, as a general rule, though this is not always the case; it is more common in the young, and in the very old. It most resembles scurvy, in its general character, though it differs from it in not being prevented nor cured by fresh vegetable food. In purpura, the gums, although purplish, do not soften, nor swell, nor ulcerate, as in scurvy.

Treatment.—The main indication is to correct the low state of the blood, by a milk diet and tonics; astringents for the hemorrhage; also opium.

HEMORRHAGES.

EPISTAXIS.—BLEEDING FROM THE NOSE.

There is no part of the body more disposed to hemorrhage than the pituitary membrane, and none in which the recurrence of the discharge is productive of so little injury, as respects either the structure or the constitution. The blood effused from this membrane may be discharged either by the nostrils or by the mouth, after having passed into the posterior fauces.

Causes. — In its idiopathic states, epistaxis occurs most frequently in children and young persons. In the more mature periods of life, it is most frequently symptomatic, or dependent upon disease of the heart, of the liver, spleen, or of some other viscus, or consequent upon the disappearance of some sanguineous or other evacuation. The *external* causes are, injuries, irritants, exposure of the face to fires or to the sun's rays. The *internal* causes are, whatever increases the flow of blood to the head, as mental excitement, sneezing, catarrh, &c., &c.

Symptoms. — The sthenic form is ushered in by pain of the head, vertigo, or somnolency; with increased pulsation in the temporal arteries. The sthenic epistaxis is often symptomatic or *critical* of several acute diseases, especially the more inflammatory kinds of fever, and inflammations of the brain, or of the lungs, &c. The passive forms are frequently symptomatic of several cachectic maladies, and of the last stages of malignant or low fevers. The quantity of blood discharged may vary from a few drops to many pounds; and in the more obstinate passive states the patient may be reduced to the utmost danger, or may be carried off in a few hours or days, according to the continuance or violence of the discharge.

Treatment.—If the patient be robust or plethoric; if he have experienced attacks of determination of blood to the head; the discharge should not be arrested until the vascular system is relieved, and when this is accomplished the epistaxis will cease of itself. If it should seem to cease prematurely, and particularly if the above symptoms still continue, depletions, purgatives, and an antiphlogistic regimen ought to be prescribed.

When it is requisite to check the hemorrhage, the patient ought to be placed in a cool, airy apartment, with the head elevated or held upright, and the feet plunged in warm water containing mustard. The neck should be bared, and cold fluids aspersed over it and the face, or ice applied upon the nape of the neck or upon the forehead; and an active cathartic exhibited; the sulphate of magnesia with sulphuric acid is the best. Lemonade and cooling drinks may also be given. When the epistaxis has become habitual, or periodic, and especially if it be vicarious of menstruation, it may be anticipated by cupping on the nape of the neck.

In the *passive* or *atonic* states of the disease, astringents should be injected into the nostrils, and astringents and tonics given internally. A solution of alum may be injected into the nostrils; or lint, moist with this solution, introduced, or powdered alum blown up the nostril. The acetate of lead, and small doses of opium, may be exhibited with advantage. If the bleeding will not stop, the anterior and posterior apertures of the nostrils should be plugged.

HÆMOPTYSIS AND PULMONARY APOPLEXY—HEMORRHAGE FROM THE RESPIRATORY ORGANS.

Hæmoptysis is one of the most frequent varieties of hemorrhage, owing to—1st, the very extensive bronchial and vesicular surface to which the blood is circulated for the purpose of undergoing the requisite changes during respiration; 2d, to the delicate conformation of the capillaries of the mucous membrane of this part; 3d, to the liability of the lungs to congestions, from impaired nervous power, from obstructions of the pulmonary veins, and of the circulation through the left side of the heart, and from tubercular or other lesions of the substance of the lungs.

We may admit three principal sources for the blood which is expectorated in hæmoptysis. It may come, *first*, from the mucous membrane of the bronchi; *secondly*, from a vessel ulcerated in a tuberculous excavation; *thirdly*, from an aneurism of the aorta, or of the large trunks arising from its transverse arch, in which case it will be soon fatal.

Pathology.—Some few cases of hæmoptysis depend on suppression of the menses, and are habitual and not dangerous; but in by far the majority of cases it depends on disease of the heart, or on the irritation of tubercle. Hypertrophy of the right ventricle is generally supposed to be a frequent cause of pulmonary hemorrhage; but the momentum caused by hypertrophy of the right ventricle is rarely sufficient to rupture any branch of the pulmonary artery. Dr. Watson states "that every instance of pulmonary hemorrhage dependent upon organic disease of the heart, which he had observed, coincided with disease on the left side of that organ, mechanically obstructing the return of blood from the lungs. The obstacle has sometimes been placed at the entrance of the aorta; but it has most commonly consisted of narrowing of the left auriculo-ventricular orifice, and a rigid condition of the mitral valve."

When these morbid states exist, it is easily brought on by violent exercise, or anything that irritates the lungs.

Pulmonary hemorrhage may be *simple*, the blood being all spit up; or it may be attended with what is most improperly called *pulmonary apoplexy;* that is to say, an infiltration of blood into the minute tubes and air-cells, rendering a portion of lung solid. This, as Dr. Watson has shown, is an accident of pulmonary hemorrhage, and occurs in this way: A portion of the blood, instead of being coughed out, is drawn back by the patient's inspiratory efforts into one or more small tubes, and fills and blocks up one or more lobules, giving rise to one or more knobs or masses, composed of blood that has coagulated in the air-vesicles. Sometimes, though not often, the latter are broken down and ruptured by it. In other cases, hemorrhage occurs in the minuter tubes and vesicles, and goes on clogging up a large portion of lung progressively; there being not the circumscribed lumps just described, but a large irregular diffused solidification.

Symptoms. — Some degree of pain or oppression at the chest, with cough, which brings up mouthfuls of blood, fluid or clotted. The quantity may vary from a teaspoonful to several pints; so that the patient may be suffocated by the abundance of the hemorrhage.

The stethoscope is useful, as indicating the extent and place of the hemorrhage, for wherever there is blood in the air-tubes or vesicles, there will be a corresponding crepitation, or if the lung is solidified, there will be absence of respiration.

After pulmonary apoplexy, the blood is expectorated in dark-red sputa, mixed with mucus.

Treatment—When the pulse is full, strong, and vibratory, bleeding is required, and the quantity of blood abstracted will necessarily depend on the strength of the patient. One bloodletting of twenty or twenty-four ounces on the first or second day, will have more effect in checking the hemorrhage than several pounds taken away in the course of a fortnight. When the patient's powers will not admit of general depletion, cupping or leeches should be resorted to. A free current of cold air should be allowed to pass over the patient, who should be lightly covered; the bowels should be opened with Epsom salts and sulphuric acid; and the best remedy is the acetate of lead with opium. Perfect silence should be enjoined; the diet be very meagre, and comprise lemonade or other acid drinks. If the hemorrhage assumes a passive character, alum, with dilute sulphuric acid, may be administered. In slighter cases, saline draughts, with small doses of digitalis, may suffice. Any inflammatory or irritative symptoms must be treated by blisters and other remedies that have been adverted to when speaking of phthisis.

HÆMATEMESIS—HEMORRHAGE FROM THE STOMACH.

Causes.—Whatever irritates the mucous surface of the stomach, or interrupts the return of blood from that organ, will occasionally produce this disease. Blows and injuries on the abdomen, particularly on the hypochondria and epigastrium; violent concussions of the trunk; external or internal pressure on the stomach; the ingestion of irritating or hurtful matters into this viscus; intemperate indulgence in food or stimulating liquors; the presence of worms in the stomach or upper part of the small intestines; powerful or irritating emetics, especially when given in the advanced stages of fevers, or in cachectic or visceral diseases; the suppression of accustomed discharges, particularly the menstrual or hæmorrhoidal; the application of cold, or of cold and moisture, to the lower extremities or surface of the body during perspiration or the catamenial period; neglect of the bowels, and consequent accumulation of fæcal matters; diseases of the vessels of the stomach and neighbouring viscera; the gravid uterus, and large tumours developed in any part of the abdomen.

Symptoms.—In most cases, there are *premonitory* symptoms, such as tension or pain about the epigastrium, with faintness, or a sense of

sinking, or of anxiety, at this region; flatulent or acrid eructations; lassitude with irregular chills and flushes of heat. The *pathognomic* phenomena of the disease are, nausea, followed by vomiting of blood, either fluid or coagulated, pure, or mixed with the contents of the stomach. The blood and other matters thrown up come away with more or less effort, frequently with comparative ease, even when the hemorrhage is greatest, and seldom with much previous retching; it is sometimes gulped or eructated upwards. When the quantity of blood thrown up is great, the effort at ejecting it may sometimes occasion irritation in the pharynx, and excite coughing, and, from this circumstance, cause some doubt as to the seat of the effusion; but the history of the case will easily show the nature of the disease. After an attach of hæmatemesis, the bowels are generally relaxed, and the dejections dark-coloured, from the presence of blood in them, and extremely fœtid. Sometimes the evacuations are quite black, and of the consistence and appearance of tar. This state of the evacuations (the *melæna* of old authors) often continues for some time after the vomiting has ceased; and they are often preceded by colicky pains through the abdomen, distension, flatulence, tormina, and even slight meteorismus.

The *physical characters* of this hemorrhage which require notice are merely those which are referable to the colour, consistence and quantity of the effused blood. The blood effused into the stomach and intestines is seldom found to present its natural red colour, either when thrown out from these organs, or when contained in them after death. It has often acquired a dark purple, and still more frequently a deep brown tint, or even the blackness of soot. The dark brown and sooty discolorations of the blood may always be regarded as the result of the action of an acid chemical agent, formed in the digestive organs, on the effused blood, except in those cases in which they are produced by the action of an acid poison. Hence we may conclude that the diseases called *black vomit* and *melæna* are mere modifications of gastric and intestinal hæmorrhage, the black colour being an accidental circumstance of no importance, and derived from the chemical action of the acid product on the blood, previous to its evacuation. The *consistence* of the effused blood is very generally increased with the darkness of colour which it has acquired. It is sometimes coagulated into large masses, or into a multitude of smaller portions, resembling a mixture of water, blood, and soot. This appearance is peculiarly characteristic of the action of an acid on the blood. The *quantity* of blood effused may vary from a few ounces to several pints; and although it is generally greatest in cases of perforation of an artery of the stomach, it is sometimes no less abundant when it has its source in exhalation from the mucous membrane.

Of the different *local lesions* which are found to accompany gastric and intestinal hemorrhage, follicular ulceration is, perhaps, the most common. The mucous membrane may be perfectly pale when the he-

morrhage has proceeded from perforation of an artery; red and vascular when preceded by congestion; or it may be of a deep red colour throughout a great extent, whatever be the source of the effusion, from imbibition alone. It almost always presents this deep red colour when the hemorrhage arises from a mechanical obstacle to the return of the venous blood, the submucous tissue being at the same time in a state of great congestion, and infiltrated with blood.

Treatment.—In plethoric and robust persons, in cases depending on congestion of the liver or spleen, or upon suppressed discharges, and where there are indications of increased or sthenic action, we should have recourse to copious or repeated *bloodlettings*, according to circumstances. *Cupping* over the hypochondria, purgatives, cathartic enemata, and external *derivatives*, should be resorted to. In the more active forms, a full dose of *calomel*, followed in a few hours by a purgative draught, and this by a cathartic enema, so as to procure copious alvine evacuations, should precede the use of astringents. When the hemorrhagic discharge is so copious as to forbid the delay which this practice would occasion, the calomel should be followed in a short time by a full dose of oil of *turpentine*, given on the surface of milk or of some aromatic water, or of this medicine conjoined with castor oil. If this draught be thrown off the stomach, it should be repeated; and it may be even again preceded by the calomel. Notwithstanding its usual nauseating effect, turpentine is generally retained in hæmatemesis, and it allays the vomiting by arresting the hemorrhage.

Of the *astringents*, the acetate of lead, in large doses, with opium, or with pyroligneous acid, acetate of morphia, and creasote, is the most efficacious. In the more *passive* states of the disease, the tonic astringents, as the tincture of the chloride of iron, the oil of turpentine with aromatics, the sulphates and sulphuric acid with opium and infusion of roses, and alum-whey, are generally useful.

During the continuance of the discharge, total abstinence should be enjoined; but afterwards, mild mucilaginous drinks, and farinaceous food in small quantity, may be allowed, and the transition to solid and more nutritious diet carefully and gradually conducted. The drink should be cooling and astringent, and appropriate to the state of the digestive organs, especially the liver and spleen. Subsequently, change of air, regular exercise on horseback, and the use of deobstruent mineral waters, ought to be recommended.

HÆMATURIA—HEMORRHAGE FROM THE URINARY ORGANS.

Symptoms.—The source of blood voided through the urethra may be either the kidney, ureters, bladder, or urethra. When it proceeds from an affection of the kidneys, it is attended with a sense of heat and pain in the loins, and sometimes with coldness of the extremities, *and the blood is intimately mixed with the urine.* When the disease is in the ureters, there is a sense of pain and tension in their course; *and coagulated shreds of fibrine, having the shape of the ureters, are fre-*

quently voided. When the hemorrhage is from the bladder, it is usually preceded by heaviness and tension above the pubes, extending to the perineum, groins, and lumbar region; the passing of the urine is attended with pain and difficulty; the blood is little, if at all, combined with the urine. When the hemorrhage is from the urethra, pain is felt in a particular part of the canal, and the blood is red, liquid, and pure, and generally is voided *guttatim*. When the blood, however, flows back into the bladder, some uncertainty as to its origin is produced.

Hemorrhage of the urinary organs presents little worthy of notice, as regards its *physical characters*, except when it occurs in the bladder. In this organ, it takes place from isolated points of the mucous membrane, which, as well as its sub-cellular tissue, presents a number of deep-red patches, varying from a line to half an inch in diameter, the larger ones having often a small ash-coloured slough in their centre. These patches consist of blood effused into the mucous and sub-mucous tissues, and are accompanied by venous congestion of those tissues where the effusion has not taken place. This form of hemorrhage is chiefly observed in injuries of the spine; and appearances perfectly similar sometimes follow the application of blisters to the chest, abdomen, and other parts of the body. The most frequent cause of hemorrhage from the urinary organs is the presence of the fungoid disease in the prostate, and hence its much greater frequency in the male than in the female.

Treatment.—The treatment of this affection will, of course, depend on its seat and cause. When the hemorrhage is from the kidney, if the patient be strong, and the pulse full, either general or local depletion, with the usual antiphlogistic treatment, is requisite. On the contrary, when the patient is debilitated, as in typhus or scurvy, the urine being generally alkaline, the mineral acids should be given. In ordinary cases, when neither excitement nor depression is present in a marked degree, small doses of copaiba, turpentine, or of the *tinct. ferri chlorid.*, the latter of which is the best, are to be administered. The avoidance of all stimulants, and absolute rest, should be insisted on.

DROPSIES.

If, in man, a large venous trunk be compressed or obliterated, so that the blood no longer circulates through it, whilst at the same time the collateral vessels can relieve but imperfectly the principal vein thus obstructed, an effusion of serum is sure to take place. But if the obstruction exists not merely in the veins of a limb, if it occur in a vessel into which the blood of a much greater number of parts empties itself, then the dropsy will necessarily become more considerable. If, for instance, the obstacle to the return of the blood should exist in the abdominal vena cava, the two lower extremities, as also the scrotum, will become filled with serum. If it be the trunk of the vena portæ which is more or less completely obliterated, it is in the peritoneum

that the serous collection will first take place; it in this way we may suppose that certain diseases of the liver become causes of ascites. If, in fine, the obstacle to the free return of venous blood exists at the very centre of the circulation, namely, at the heart, we must then draw the theoretical conclusion, that in this case, the circulation of the venous blood being everywhere embarrassed, serous collections must form in all directions, and the dropsy become general. This case, anticipated by theory, is actually established by experience; all practitioners know *that dropsy is one of the most common symptoms of the different organic affections of the heart.*

The next cause of dropsy is *cold*, applied in such a manner as to check the secretion of the skin. From this cause we have frequently general anasarca, and effusions into the pleuræ, the pericardium, the peritoneum, &c. These cases are, from the attendant constitutional symptoms, called *inflammatory dropsy*. A *third* cause of dropsy is some exanthematous disease, and especially scarlatina. A *fourth* cause of dropsy is the granular degeneration of the kidney, first pointed out by Dr. Bright, and elucidated by the admirable researches of Dr. G. Johnson, of King's College.[1] A *fifth* source of dropsy is debility, exhaustion from loss of blood, &c. A *sixth* and frequent cause of dropsy is obstruction to the flow of the venous blood, owing to tumours pressing on the large venous trunks, and glandular enlargements, as hypertrophy of the liver, &c.

The presence of *albumen in the urine* depends on the presence of *blood*, or else of the *serum of blood*. If serum only be present, the albumen may be detected by boiling a portion of urine, and adding nitric acid; if the entire blood be present, the red particles may be detected by the microscope, and will render the urine *smoky* or dusky in colour.

These conditions of the urine in dropsy depend on a congested, or irritated, or diseased state of the kidney, so that the capillaries of the Malpighian bodies either exude serum, or else are ruptured and pour out blood.

NEPHRITIC DROPSY—DROPSY FROM BRIGHT'S KIDNEY

Dr. Bright first pointed out, in 1827, the frequent connexion which exists between dropsy and what has since been called granular degeneration of the kidney, and the presence of albumen in the urine, as an indication of the latter lesion; but it was reserved for Dr. G. Johnson, of King's College, to detect the real nature of this most prevalent and fatal disease.

Pathology.—This state of the kidney is not an inflammation, but a slow *degeneration of structure*, commencing by an abnormal deposit of fat in the epithelial cells lining the uriniferous tubes. It is a de-

[1] See two excellent lectures, by Dr. Todd, of King's College, in the London Med. Gaz., Dec. 19th and 26th, 1845.

generation, therefore, much allied to the tubercular deposit, or to the fatty liver common in phthisis, and may properly receive the name of the *fatty kidney.* It is a slow insidious disease, beginning generally much further back than the patient is aware of.

The uriniferous tubes become by degrees blocked up with an excessive accumulation of fatty epithelium; the result of this is, that the tubes become dilated, so as to press on the portal plexus of veins which surround them. The veins being thus compressed, the Malpighian capillaries, which open into them, are unable to discharge their contents, and so become distended with blood; and either allow serum to exude from their walls, or else burst and admit the escape of red particles and fibrine. As the accumulation goes on, portal plexuses and uriniferous tubes become atrophied, and hence, shrinking of the kidney and deficiency of secretion ensue. As, however, some Malpighian tufts remain healthy, the secretion from these is sometimes abundant, or even excessive.

The *morbid anatomy* is thus described and explained by Dr. Todd:—

1. "Both kidneys are found in a diseased state. It seldom or never happens that the disease is limited to one kidney.

2. "We meet with irregular vascular congestion, the vessels are full at some parts of the organ, and empty at others, and this gives rise to a mottled appearance on the surface of the kidney.

3. "A deposit of a new matter is found either in or between the tubes of the kidney; this deposit has hitherto been called *granular.*

4. "As the disease advances, the kidneys, which at first were enlarged, shrink, their cortical or external portion becoming wasted, here and there leaving depressions on the surface of the organ, corresponding to the wasted portions; and thus a tuberculated aspect is given to the kidney. The blood-vessels are obliterated in many situations, and it is impossible to inject such kidneys."

Constitutional Symptoms.—These may be divided into three stages.

In the first, the patient is weak and dyspeptic; and his *blood loses its red particles* in an extraordinary degree; but there is very little to call attention to the kidney.

In the second stage, the symptoms are, a pallid, pasty complexion, dry hard skin, drowsiness, weakness, indigestion, and frequent nausea, often retching the first thing in the morning, and palpitation of the heart. A most characteristic symptom is, that the patient is awakened once or twice in the night, with desire to make water.

In the third stage, if the patient is exposed to cold, the kidney becomes congested; anasarca with, perhaps, ascites, makes its appearance; debility increases; the secretion of urine becomes more inefficient, urea and other excrementitious matters accumulate in the blood; and drowsiness and coma, signs of effusion into the head, are sure precursors of death.

Of the state of the urine.—In the first stage, if examined, it will often be found to contain particles of epithelium, loaded with fat.

In the second stage, the urine is *albuminous*, and not only so, but contains sometimes red particles of blood, and little *fibrinous shreds*, moulds of the tubuli uriniferi, in which they have coagulated. Its *specific gravity is generally very low;* instead of 1025, the healthy average, it sinks to 1016, and gradually gets lower; down, perhaps, to 1004. It will often be found under the microscope to contain a large amount of fatty epithelium scales.

In the last stage, the quantity of urine is very variable; sometimes very scanty, or even suppressed, so that the patient dies comatose, from the urine retained in the blood; sometimes extremely abundant; and sometimes before death the albumen entirely vanishes.

Consequences.—This fatty disease of the kidney, besides dropsy, and fatal coma, is apt to induce acute inflammation of the serous membranes, disease of the heart, and obstinate indigestion.

Causes.—It may be caused by intemperance, privation of air and light, and neglect of proper exercise; frequent exposure to cold, and the other causes of scrofula and phthisis.

Treatment.—If the disease assumes an *acute* character, with pain in the loins, fever, and evidence of renal congestion, cupping should be performed on the loins. But in most cases the treatment should be so conducted as to keep the emunctories open, and reduce the strength as little as possible. The skin should be kept open by baths; the bowels by saline purgatives; and in the intervals of purgation, the kidneys should be solicited by the milder kinds of saline diuretics, such as tartarized soda. When there is an absence of fever the tartarized iron can sometimes be borne. Lastly, the diet should be plain and as nourishing as the stomach will digest, and fatty matters should be excluded from it as much as possible.

HYDROTHORAX, DROPSY OF THE PLEURAL CAVITIES.

It was formerly the common opinion, and is even now believed by many, that *idiopathic* hydrothorax is a very common disease, producing a formidable array of symptoms, and often causing death by suffocation. In late years, the erroneousness of this opinion has been shown, on the one hand, by the study of pathological anatomy, which has discovered, in the supposed cases of simple hydrothorax, extensive organic disease, without any effusion; and, on the other hand, by auscultation and percussion, which have not only proved the same during life, but have likewise taught us that hydrothorax, when it does exist, can have but a very small share in producing the symptoms that have hitherto been ascribed to it.

Symptoms.—The patient feels an oppression and difficulty of breathing, and generally lies on the affected side, leaving the healthy one unencumbered in its functions. When the fluid is in both cavities, the respiration is still more difficult and short; the patient sits up in

bed, and calls in the aid of all the muscles of inspiration; and his countenance assumes a cast of anxiety. Corvisart describes the chest as being more distended and rounded on the side which contains the fluid; and as the collection increases, the intercostal spaces are widened, the integuments of this side becoming œdematous, and in a few instances, the arm on the same side. In the acute states of this disease, a feeling of soreness, tenderness, or pain, is often complained of in or over the seat of effusion. *Symptomatic* hydrothorax will combine with the common signs of pleuritic effusion those of whatever organic disease it is the consequence; and this will generally be found to be some lesion of the circulatory apparatus, by which its function is extensively impeded. Laennec states that it scarcely ever supervenes earlier than a few days before the fatal termination of such diseases, and may therefore be considered the immediate harbinger of death, the agony of which it increases by dyspnœa.

Physical signs.—On *percussion*, a flat sound is emitted, resembling that produced by striking the thigh, on the side containing the fluid, or on both sides when the effusion has taken place into both. When the patient sits, or stands up, and the fluid only partially fills the cavities, the lower part of the thorax only will give out a dead sound. This sound generally changes its place with the change of position, owing to the gravitation of the fluid to the depending part. This, as M. Piorry contends, is an important diagnostic between the dead sound of effusion and that produced by hepatization of the substance of the lung, which always retains the same situation. Upon *auscultation*, the respiratory murmur is found to have ceased in the region corresponding to the fluid collection; and in its place is heard the *bronchial* respiration. When the effusion is not very great, *ægophony* is occasionally heard. If the fluid be accumulated only in one cavity, *mensuration* of the thorax then becomes a useful mode of diagnosis; but the increased fulness of one side, and widening of the intercostal spaces, may be recognised at sight.

Treatment. — The plan of treatment must depend upon the cause of the effusion, which may be an organic lesion of the heart or lungs, or inflammation of the pleura; and these are to be managed on the general principles laid down when treating of those affections. *Cathartics* and *purgatives*, especially the hydragogues, often afford speedy relief; but they are admissible only when the powers of life are not greatly reduced, and in the more acute cases, not caused by inflammation of the pleura. *Diuretics* are more certainly beneficial in this dropsy than in any other; and of this class *digitalis* is the most efficacious, particularly in the form of infusion. All authors agree in admitting the power of digitalis in this affection. Where there is much prostration of vital energy, we should combine *tonics*, and *antispasmodics*, with the diuretic medicines. *Paracentesis thoracis*, once so strenuously advised, is seldom or never resorted to, excepting in empyema. The chief danger in this operation proceeds from the in-

troduction and action of the air; but not so much from its preventing dilation of the lungs as from its action on the diseased pleura and the fluid effused from it, which becomes putrid and poisonous.

ASCITES—DROPSY OF THE ABDOMEN.

Ascites, or dropsical effusion within the abdomen, may exist either alone or complicated with hydrothorax and general anasarca.

Causes.—The great extent of the peritoneum, the number and importance of the viscera with which it is connected, and of the absorbent glands it encloses, the numerous sources of disorder to which these organs are exposed, the great number and weakness of the veins which transmit their blood to the portal vessels, and the absence of valves from them, in some measure account for the frequent accumulation of fluid in this cavity. Ascites may arise at any age. Camper, Lee, and others, have observed it in new-born infants; but it is most common in women and aged persons. It occurs more frequently in married than in unmarried females; and is often the consequence of the distension and pressure attending pregnancy, of difficult or instrumental labours, and of suppression of the puerperal secretions, or of the perspiration, of catamenia, or of the disappearance of this last evacuation.

Pre-existent disease is generally the cause of ascites, particularly diarrhœa or dysentery, and sudden interruptions of these discharges; intestinal worms; organic lesions of the liver and spleen, especially obstructions of their venous circulation; inflammation of the vena portæ, and obliteration of one or more of its principal branches; the suppression of chronic eruptions, or of the exanthemata, — as scarlet fever, erysipelas, &c.; acute or sub-acute peritonitis; organic change of the structure of the kidneys; the rupture of cysts into the abdomen; uterine or ovarian disease; intermittent or remittent fevers; excessive evacuations and hemorrhages.

Symptoms.—Idiopathic ascites generally assumes an *acute*, or even *inflammatory* form. It usually occurs either in the young, the robust, or well fed, and presents all the symptoms of the phlogistic diathesis; the pulse is hard, thirst increased, the urine scanty; the skin is warm, hot, or coloured, and resists more or less the pressure of the finger. There are evidences of inflammatory or excited action of the peritoneum, with pain, tenderness, and sometimes tension of the abdomen; a quick, small, hard, or wiry pulse, and suppression or diminution of all the secretions or excretions. Either consecutively to, or concomitantly with, these symptoms, fulness of the abdomen is observed, which usually augments rapidly. At first, the increase is most remarkable in the lower part of the abdomen and iliac regions when the patient is sitting up, and the liver is not enlarged; but it is always diffused when the patient is in the supine posture, and without any limitation or tumour. Upon examining the abdomen, a dull sound is emitted by percussion, and fluctuation is easily perceived. As the effusion aug

ments, all the abdominal functions are more and more disturbed, and at last respiration becomes difficult from the pressure of the fluid impeding the descent of the diaphragm, and the patient is unable to lie down. The abdomen is now large and prominent in its upper regions, and pushes, particularly in young subjects, the ribs and cartilages upwards. Irritability of the stomach, anxiety, restlessness, want of sleep, great quickness of pulse, sometimes delirium, and ultimately coma and death, supervene, if temporary or more prolonged relief be not obtained from treatment.

Ascites may be mistaken for tympanitis, ovarian dropsy, and for pregnancy. *Tympanitis* is readily recognised by the clear resonance furnished on percussion, by the absence of fluctuation, and of the œdema of the lower extremities, and by the history of the case. *Ovarian dropsy* is never general or uniform in its earlier stages, like ascites; and fluctuation is usually very obscure, and to be detected only in the situation of the tumours, the circumscribed form of which may be determined until a very advanced period of the disease. *Pregnancy* is distinguished from ascites by the state of the os uteri upon examination, by the progress of the enlargement, and the defined form of the uterus when the patient is supine, and the abdominal muscles relaxed; by her unbroken health and clear complexion,—the countenance of dropsical persons being pale, sickly and cachectic; by the enlargement and firmness of the breasts, and the deep colour of the areolæ,—these organs being soft and flabby in ascites.

Let the patient lie on the back, and percuss the abdominal parietes; in ascites, they generally yield a dull sound towards the back, where the fluid settles, and clear in front, because the bowels float upwards through the serum. It is the reverse in pregnancy and ovarian dropsy.

Treatment.—This must depend, as in other dropsies, upon the organ affected, and upon the extent and nature of the disease. The *acute* forms require vascular depletions, general or local, or both, to an extent which the pulse and symptoms indicate. Mercurials and antimonials, at first so as to act on the bowels, and subsequently as alteratives, or with opium, and pushed so far as to affect the mouth; external irritants and derivatives; deobstruent diuretics; diaphoretics, and warm or vapour baths, followed by oleaginous frictions of the skin, in order to restore its perspiratory functions; and lastly, gentle tonics conjoined with purgatives, or with diuretics, and assisted by warm, iodine, or medicated baths, will frequently succeed in removing disorder, if early employed, and if a vital organ have not experienced serious structural change. The *symptomatic* forms of ascites must be treated with strict reference to the original lesion or malady, so far as that can be ascertained. *Graduated compression* of the abdomen, by means of the belt recommended for ascites by the first Munro, has been employed successfully by Professor Speranza and M. Godelle, and, when it can be borne, may prove serviceable in some asthenic and chronic states of the

disease. With respect to *paracentesis abdominis,* it should be avoided as long as possible, and, although it should not be proscribed from practice, the cases are few that will be benefited, and still fewer that will be cured by it.

SECTION IV.

DISEASES OF THE SECRETORY ORGANS.

DISEASES OF THE LIVER.

HEPATITIS.

Inflammation may affect either the substance of the liver or its investing membrane,—one, or all the lobes; it may be acute or chronic.

Symptoms of Acute Hepatitis.—General febrile excitement; lancinating or dull pain of the right side, increased on full inspiration, and on pressure, which should be made while in the recumbent posture; a sympathetic pain is also sometimes felt in the right (very rarely in the left) shoulder, and along the neck. Sense of uneasiness at the stomach, and nausea or vomiting; short, dry cough; hiccup; bowels constipated; pulse frequent and hard; and the urine high-coloured. The patient commonly lies on the right side, and the skin is often tinged with the yellow colour of jaundice. Rigors indicate suppuration. The abscess may open into the colon, the stomach, the lungs, the cavity of the pleura, or the peritoneum.

Causes.—The ordinary causes of inflammation, but especially long residence in tropical countries, which causes the liver to act inordinately in order to eliminate the excess of carbon from the blood, this gradually produces congestion, which ends in inflammation. The excessive use of alcohol acts much in the same way. Miasmata likewise produce it; so also do disease of the heart, duodenal inflammation, and dysentery.

Morbid appearances.—When the substance of the liver is inflamed, it becomes brittle and friable; the granulations are larger and more red than natural, and the lining membrane of the biliary ducts is injected and of a reddish-brown colour. In most cases, abscesses are found in different parts of the liver, or the greater part of the organ may be converted into one large cyst containing pus. In other cases, the purulent matter is infiltrated into the substance of the gland. Dr. Budd has called attention to the fact, that the abscesses in the liver, following dysentery, are often owing to an inflammation of the hepatic veins.

Treatment.—General and local bleeding, mercurial and saline purging, diaphoretics, &c., with an earlier resort to the constitutional

impression of mercury than in most other phlegmasiæ. The especial tendency of this medicine to the liver is owing to its entrance into the vena portæ.

CHRONIC HEPATITIS

Is denoted by more or less pain and tenderness, or weight and fulness, in the right hypochondrium, with sallowness of the skin, emaciation, and depression of the spirits. It may be a consequence of acute inflammation, or of long residence in unhealthy climates, or of diseases of the heart; one very frequent cause is *intemperance.*

Sometimes the liver increases greatly in bulk, and may be felt low in the abdomen, or its limits be ascertained by percussion. Sometimes, on the contrary, it is shrunken and atrophied.

One common form of disease, which is often a precursor of ascites, is what is called the *hob-nailed liver.* This disease originally consists in an inflammatory thickening of Glisson's capsule, which forms a sheath for the portal vessels, the hepatic artery, and biliary ducts. The thickening of this cellular sheath may compress the biliary ducts, and so cause jaundice; or the portal veins, and so cause ascites. Finally, the thickened cellular sheath shrinks and becomes atrophied, and by its shrinking compresses the hepatic artery, and so causes general atrophy of the organ; whilst by its shrinking it leaves the lobules projecting as little rounded eminences, like the heads of nails.

The appearance called *nutmeg liver,* is a mere consequence of congestion. If, after death, the hepatic vessels, which run in the centre of each lobule, are injected, the liver presents on its surface numerous red spots, with pale interstices. If, on the contrary, the portal system only is injected, it will display pale spots corresponding to the lobules, with red interstices.

Treatment. — The general rules in treating chronic hepatic disease are, to diminish congestion of the portal vessels; to keep up the secretion of the urine, to allay irritation, and support the strength. Small doses of mercury with squill; saline aperients, and diuretics; taraxacum; sulphate of manganese; muriate of ammonia; iodine; colomba, and other light tonics; nitro-muriatic acid, given internally, and used as a bath for the legs; occasional leeching, blistering, or frictions with mercurial ointment, or with iodine; Cheltenham waters, and a light nourishing diet, are the main remedies.

CIRRHOSIS, OR GRANULAR DEGENERATION OF THE LIVER.

In this disease the liver becomes filled with granulations of different sizes, not tuberculous, projecting beyond the surface. It is usually contracted in size, and of a yellowish-brown, or even a canary colour.

Nature. — Not perfectly understood. The ultimate cells appear to secrete an abnormal matter, which possibly may be a morbid condition

of fat. The cells then enlarge, and press upon the acini, so as to cause their absorption.

The *symptoms* are not very obvious, hence it often escapes detection. There are often dyspeptic symptoms with some uneasiness in the hypochondriac region, with, ultimately, dropsical effusion. The intemperate are especially liable to it.

The *treatment* should be similar to that of chronic hepatitis.

FATTY DEGENERATION OF THE LIVER.

The liver is here generally enlarged, the surface of a bright-yellow colour, smooth, with reddish specks throughout. When cut into, a greasy stain is left upon the knife. The cells are filled up with an oily matter.

The *cause* depends upon some depraved condition of the ultimate cell-action, whereby fat is produced, instead of the normal secretion; it occurs chiefly in the intemperate, and in phthisis.

The *treatment* consists in invigorating the general system; cod-liver oil is indicated, just as in phthisis.

Other organic diseases of the liver, which it will be sufficient here to mention, are *tubercle, scirrhus, cysts, hydatids,* and *melanosis,* the diagnosis of which, during life, is very obscure.

FUNCTIONAL DISORDER OF THE LIVER.

CONGESTION OF THE LIVER.

Active congestion may depend on the same causes that produce inflammation; *passive* congestion is caused by some obstruction in the portal circulation, or by valvular disease of the heart.

Signs.—Often enlargement; a sense of oppression; lowness of spirits; loss of appetite; nausea; furred tongue, &c.

It is apt to produce congestion of the whole portal system; hence it frequently ends in diarrhœa, dysentery, enteritis, or cholera morbus.

Treatment.—In the active form, bleed and give a mercurial purge; and, if persistent, use mercury in alterative doses. In the passive form, endeavour to remove the cause, and use the alterative course of mercury, or nitro-muriatic acid.

DERANGED SECRETION OF THE LIVER.

It may be excessive, or deficient, or morbid: in each of which cases, the particular condition is ascertained by inspection of the stools. These will be copious and of a bilious character, if the secretion is excessive; but small, clay-coloured and dry, if it is deficient; or black, or intensely green, if it is deranged.

The *treatment* in all cases consists in giving minute doses of calomel or blue-pill, and opium, as one-sixth grain of calomel with one-twelfth grain of opium, every hour, until two grains of the mercurial are taken; and follow, the next day, with a saline laxative.

GALL-STONES.

Gall-stones may exist in any part of the biliary passages; they are also extremely various, both in size, number, and shape. They may so entirely fill up the gall-bladder, as to excite ulceration and fatal peritonitis. The *causes* of gall-stones are obscure, but their formation is frequently connected with imperfect assimilation of the nutriment. They are composed of the colouring matter of the bile and of cholesterine.

Symptoms.—Biliary concretions often pass into the duodenum without causing any disturbance; on other occasions, the patient is suddenly seized with acute pain in the right hypochondrium, increased on the slightest motion, and shooting backwards under the scapula; the pain is increased after meals. There are also nausea, vomiting, distention of the abdomen, and alternations of diarrhœa and constipation. The paroxysms occur at irregular intervals; the pulse is commonly natural, and the skin cool.

Treatment.—The treatment of biliary calculi, or rather of the irritation produced by their passage into the duodenum, is merely palliative. Opium, or its salts, should be frequently administered, to relieve the agonising pain, which is frequently the most prominent symptom, and warm anodyne fomentations should be applied to the abdomen; the inhalation of ether has often given prompt relief during the paroxysm. Dr. Prout recommends large draughts of warm water containing carbonate of soda in solution. The warm bath will also be useful in allaying spasm. When we have reason to think that the gall-stones have been evacuated, the patient should be ordered to take a course of vegetable bitters, and occasionally alkalies; the diet should be light, and a sojourn at some of the watering-places should be recommended when circumstances will permit.

JAUNDICE.

The term jaundice is applied to a yellowish tinge of the skin and eyes, depending on the presence of bile in the circulating fluids.

Causes.—These are, diseases of the liver; obstruction to the free passage of bile into the duodenum; congestion of the portal system, or excessive secretion of bile; gastro-duodenitis, &c.

Symptoms.—The symptoms of jaundice will evidently depend on the nature of the cause which has given rise to the unnatural colour of the skin. The yellow tinge is the most prominent sign; it usually commences in the face, and thence may extend over the whole body, being most clearly distinguished underneath the conjunctivæ. The digestive functions are deranged; the bowels usually costive, and the fæces untinged by bile; the urine is high-coloured, and more or less of a saffron tint; the tongue is foul and covered with a yellow fur; the patient complains of headache, and very often of pain in the region of

the liver. The condition of the pulse is extremely variable, and the skin is usually dry, with a sense of itching or stinging.

The morbid appearances found in persons who have died with jaundice depend on the causes which have produced the disease; and they may be deduced from the enumeration of those already given.

Treatment.—The indication is to restore the hepatic secretion. First ascertain whether the liver be irritated or torpid; if the former (as denoted by pain in the side, increased by pressure), cup or bleed, give a mercurial purge, and follow by alterative doses of mercury; if the latter, which is the most common, give a brisk mercurial cathartic, and follow it by mercurial alteratives. These are to be followed, if necessary, by alkalies, taraxacum, nitro-muriatic acid, and aloes. Often there is a languid state of the digestive organs, for which the bitter tonics are required. In chronic cases, a resort to the watering-places will be beneficial.

SPLENITIS.

Signs of acute splenitis.—Pain in the left side, of a sharp or dull character, increased by pressure, coughing, or a full inspiration, and also by lying on the affected side; there are also chill and fever. It may end in suppuration. It is liable to be mistaken for inflammation of the left lobe of the liver.

Causes.—External violence, suppression of habitual discharges, congestion of the portal circle and depressing emotions.

Treatment.—In the sthenic cases it should be decidedly antiphlogistic; in the asthenic, local bleeding and revulsives, but *not* mercury; if connected with miasmatic fever, quinine is indicated.

Chronic splenitis sometimes lasts for years; it is very apt to end in dropsy. It is often connected with a cachectic condition, especially in the residents of miasmatic districts. The enlargement of the spleen is sometimes excessive.

It is usually an original disorder, arising from repeated attacks of intermittent fever, which, by producing successive congestions in the organ, occasion a permanent enlargement.

Treatment.—Purging by jalap and cream of tartar; calomel, only, in case the liver is torpid, quinia, iron, and iodine.

The spleen is also liable to similar *organic* diseases with the liver.

NEPHRITIS.

Inflammation of the kidney may occur either in its substance, its lining membrane, or in its capsule; its most frequent seat is in the pelvis.

Signs of the acute form.—Deep-seated pain in the small of the back, extending down to the groins on one or both sides, increased by pressure; urination either increased or diminished; urine scanty and high-coloured, and mixed with blood or gravelly matters. If both kidneys are affected there may be suppression of urine, and comatose

symptoms. Chill, fever, deranged stomach, and constipation nearly always attend it. In inflammation of the substance of the kidney the urine is apt to be clear; if the pelvis is involved, the urine is turbid; in gouty nephritis it contains an excess of uric acid, and is high-coloured. It may terminate in suppuration or in coma.

Diagnosis. — It is distinguished from lumbago, psoas abscess, and peritonitis, by the retraction of the testicle, by the pain shooting down into the scrotum and thigh, and by the altered character of the urine

It very rapidly runs into suppuration, the sign of which is the appearance of pus in the urine.

In *chronic nephritis* the pain is dull; the diagnosis is made chiefly from the character of the urine, as its alkalinity and excess of epithelium scales.

Cause.—External violence, as blows, &c., and the action of irritants passing into the blood, as cantharides, turpentine, a calculus in the pelvis of the kidney, &c.

Treatment.—Bleeding; cupping; purging, at first by calomel; then opium by enema; the free use of mucilaginous drinks, especially if the pelvis of the kidney be affected. In gouty cases, use bicarbonate of soda also. In revulsion, common blisters are not proper, from fear of absorption of the active principle.

In the chronic form, where there is debility of the organ, the best remedies are irritants, as turpentine, copaiba, buchu, pareira brava, uva ursi, and pipsissewa; together with tonics and a good diet.

For "*Bright's Disease,*" see *Dropsies.*

The kidneys are also liable to all the organic diseases common to other organs.

CYSTITIS, OR INFLAMMATION OF THE BLADDER.

Signs.—Acute pain above the pubes; tenderness on pressure; the pain extends into the penis, scrotum, and perineum, producing tenesmus and pain in urination. Sometimes pain over the abdomen, which is swollen. It may extend to the peritoneum, causing peritonitis.

It may terminate in suppuration, the pus appearing in the urine, or if the abscess occurs in the coats of the bladder, it may open suddenly. The urine is loaded with epithelial scales, and coagulated fibrine and blood; in the advanced stage it is always alkaline.

Causes.—Those of inflammations generally; but especially the direct irritation, as by a catheter; also by gonorrhœa, difficult parturition, cantharides, and oil of turpentine, &c.

Treatment.—The usual antiphlogistic plan, with the addition of the free use of cold mucilaginous drinks, and sweet spirits of nitre, if the mucous coat be involved; but if the muscular or peritoneal coat be the seat of the disease, give fluids sparingly, and direct the secretion rather to the skin; Dover's powder and anodyne enemata.

Chronic Cystitis, or *Catarrh of the Bladder,* is characterized by a

copious flow of mucus from the bladder, often without pain, and sometimes very thick; there is also a large deposit of the *phosphates* in the urine. In the advanced stage ulceration occurs, attended with the discharge of pus and blood. It is apt to occur in old persons, and to be associated with disease of the prostate.

The *treatment* is like that of other chronic inflammations, along with the free use of opium and stimulating diuretics, as turpentine, buchu, the balsams, uva ursi, and chimaphila. Injection into the bladder of a solution of sugar of lead at first, and subsequently of nitrate of silver, is more effectual; the mineral acids, if the phosphates are in excess; tonics and narcotics; and finally a mercurial course.

DIURESIS.

This term is used to signify a morbid increase of urine; it is synonymous with the *diabetes insipidus* of authors.

The natural quantity of the urine varies according to the season of the year, the amount of fluids drunk, the flow of perspiration, &c. *Thirst* is a usual accompaniment, either as an effect or cause. Diuresis frequently attends hysteria. The urine is pale, and of a low specific gravity.

The *treatment* depends on the cause. Excess of drinking should be avoided, and also salines and stimulants. Diaphoresis should be promoted by the use of warm baths, the use of the flesh-brush, and exercise; Dover's powder at night; tonics and iron if attended with anemia; and in debility the alterative diuretics, as copaiva.

The *albuminous* diuresis occurs chiefly in Bright's disease. In another form of the disease there is an excess of urea; this arises either from a bad assimilation of the food, or from a too rapid disintegration of the tissues. The *test* for urea is nitric acid, or the microscope. It is usually accompanied by a morbid appetite, and great emaciation; it is a dangerous disease.

The *treatment* is to correct the defective digestion by the use of mineral tonics, especially nitro-muriatic acid, also the milder diuretics.

ISCHURIA, OR SUPPRESSION OF URINE.

It frequently attends inflammatory diseases, especially acute nephritis. It may arise either from an irritation of the kidney beyond the point of secretion, or from a torpor or paralysis of the kidney. It is important to distinguish it from *retention of urine*.

Suppression is sometimes very dangerous, being attended with vomiting, drowsiness, coma, and convulsions. In other cases a vicarious secretion is established, as from the skin, bowels, &c.

The *cause* of suppression is not certainly known; it has been attributed to a sort of paralysis of the nerve-centres.

Treatment.—Copious bleeding, cupping over the loins; diuretics, as cream of tartar, digitalis, and squill; the free use of demulcent drinks. If uric acid be in excess, give carbonate of potassa; if dependent on

a torpid condition, use the stimulating diuretics, as turpentine and cantharides.

LITHIASIS, OR GRAVEL.

This disorder consists in the deposition from the urine, within the body, of an insoluble sand-like matter. In health the urine carries off the results of the waste and disintegration of the tissues in a soluble state; but when these matters are in excess, the urine frequently deposits them after being voided, on cooling. This often occurs after irregularities in diet, without being actually a morbid condition; but when the accumulation is excessive, the deposit may occur *in the kidney*, causing a serious disease.

The deposits may be either in the form of a soft amorphous powder, or in distinct crystalline grains. They may all be arranged under three heads:

1. The *uric acid diathesis*, in which uric acid, or the urates, are in excess. The deposit is either sandy, or in the form of small, reddish-yellow granules, termed *lateritious deposits*, and consisting generally of uric acid and soda. The *urates* are not always coloured; they are much more soluble than uric acid.

Causes.—An excess of acid in the blood, by decomposing the soluble urates, will cause a deposition of uric acid in the urine. The best test for it is the *nitric acid* test,—by adding nitric acid to the urine, evaporating to dryness, and then adding ammonia, and evaporating, a purpurate of ammonia is produced; also by the microscope, which exhibits the peculiar rhomboidal prisms in groups. The urine in this form is scanty and high-coloured; it occurs in gout, also in high livers who stimulate freely; also in febrile and inflammatory fevers.

2. The *phosphatic acid diathesis.*—The phosphates always exist in healthy urine, in which they are held in solution by a slight excess of acid. Hence whatever neutralizes this excess of acid, may cause a deposition of the neutral phosphates. The most common forms are the *ammoniaco-magnesian phosphate*, and the *phosphate of lime.* They are generally of a white colour, and in the form of amorphous powders, though sometimes crystalline. The *test* is their insolubility in an alkali, but their solubility in acetic or muriatic acids, and the peculiar form of the crystals under the microscope. The urine is usually decidedly alkaline. It generally occurs in feeble health, as dyspepsia, or in nervous disorders; also in acute affections of the brain and spinal marrow. It is also caused by an excess of alkali in the blood.

3. *Oxalic acid diathesis.*—This usually first presents itself in the form of a calculus in the bladder or kidney. Generally it is the absence of sediment accompanied by symptoms of stone, which excites suspicion of its existence. It is recognised by the transparent octohedral crystals (microscopic).

Little is known of its *cause.*

The *effects* of these morbid deposits are either successive attacks of *gravel*, marked by dull aching pain in the back, attended with urgent and frequent desire to urinate, preceded by cutting or scalding pains in the urethra, neck of the bladder, or in the course of the ureters; or else the concretions become so large as to constitute *calculus*, either of the bladder or kidney.

Treatment.—In the uric acid form, the alkalies are indicated, especially bicarbonate of soda given in carbonic acid water; also mild diuretics, and the free use of diluents; strict attention to diet; a very sparing use of animal food, avoidance of alcoholic drinks, and of all acescent and indigestible articles of food; the warm bath; and moderate exercise.

In the phosphatic variety, the treatment appropriate for dyspepsia is indicated; the mineral acids; the alkaline *bicarbonates* act by dissolving the phosphates; opium is specially indicated; stimulant diuretics to alter the character of the mucous surfaces; warm clothing.

The oxalic variety requires a general tonic treatment. Dr. G. Bird recommends sulphate of zinc, and in anæmic cases the chalybeates, and also colchicum. All articles of food containing this acid should be avoided.

INCONTINENCE OF URINE.

This may depend upon two different conditions: an excessive irritation of the bladder, it not being able to hold the urine; or a debility or paralysis of the sphincter muscle. Both conditions may occur at one time. The most common cases of incontinence are where the sphincter retains considerable power, but yields habitually to a slight impulse, especially in sleep, when the will cannot act. It is sometimes attended with an acrid state of the urine, which is high-coloured, and often loaded with uric acid. Again, in other cases, there appears to be a debility of the kidneys.

Treatment.—The indications are to invigorate the general system, and to give tone to the sphincter. A course of tonics, sea-bathing, cold bath, warm clothing, &c.; together with astringents and stimulant diuretics, especially the tincture of cantharides, pushed so as to produce slight irritation. Small doses of extract of belladonna have also been highly recommended.

In cases of paralysis of the bladder, applications to the spine, strychnia, electricity, and powerful local irritants, have proved beneficial.

SECTION V.

DISEASES OF THE NERVOUS SYSTEM.

HYDROCEPHALUS—ACUTE. TUBERCULOUS MENINGITIS.

Hydrocephalus is a name likely to mislead the student, as it signifies merely *dropsy of the brain;* whereas, the disease which it is used to designate, is an acute inflammation of the brain and its membranes, often, but not invariably, ending in serous effusion. The term *tuberculous meningitis* expresses the true pathology of the complaint.

Predisposing causes.—The *epochs of infancy and childhood* may be called predisposing causes, because, at these periods, the great irritability of the nervous system disposes the cerebral circulation to frequent excitement. A *scrofulous diathesis*, is also a powerful predisposing cause; and Dr. Cheyne attributes the hereditary disposition to this cause; it, however, occurs as a hereditary disease without a scrofulous taint existing. Amongst the other causes enumerated are, premature application to study; remittent and exanthematous fevers; syphilitic taint of the parents; application of cold to the head; torpor of the secretory system, &c.; but above all, the tuberculous diathesis.

The *exciting causes* are, external injuries from blows, falls, &c., concussions of the brain, from whirling or tossing the child; the suppression of eruptions on the scalp, and behind the ears; the extension of inflammation from the ear; the retrocession of acute eruptions, and suppression of chronic discharges; the extension of irritation to the membranes of the brain, from inflammation of the pharynx, scalp, face, &c.; too copious depletion in exanthematous or other diseases; metastasis of various affections; the too free use of narcotics in young children, &c.

This disease has usually been divided into *periods*, or *stages*.

First stage.—The prominent symptoms are headache, vomiting, and constipation, with febrile excitement. These spells may come on at regular intervals, so as to resemble intermittent fever, for which it has been mistaken. The tongue is furred, but moist; face pale, and alternating with flushes; the stomach is exceedingly irritable, vomiting being frequently produced on the child changing its position; and the urine is scanty and thick. The temperature of the head is much increased; the eyes extremely sensitive to light; the pupils are contracted; the brows are knit; there is an inability to sit up, and a whining or moaning noise when the child is lying down. The sleep is short and disturbed; the patient rolls its head on the pillow, or often wakens with a scream, or crying, and raises its hands to its head. Sometimes the attack begins by convulsions.

Second stage.—The sensibility is now remarkably impaired; the drowsiness increases in degree; the pupils are dilated, and there is

strabismus, and imperfect or double vision; the eyes are dull, heavy, vacant, or staring; the eyelids drooping or half closed. The pulse, from being frequent, now becomes slow, and sometimes even more so than natural, when the patient is in the horizontal position; but if he attempts to sit up, it immediately acquires its former rapidity. Slight convulsions show themselves in momentary attacks in the eyes, mouth, or upper extremities, which are tremulous. The hands either are raised to the head, or the child picks its nose or mouth. The stupor is occasionally interrupted by loud and shrill screams from the child; and partial contractions of some of the limbs begin to manifest themselves.

Third stage.—The last stage now comes on; the pulse is quick, thready, and weak; there are partial or general convulsions; and paralysis of one side or limb occurs. The pupils become more and more dilated, the eyes suffused, and the cornea dull and filmy. The patient is either comatose or delirious, rolls his head about on the pillow, grinds his teeth, and moans or breathes heavily and quickly. The skin becomes cold and covered with perspiration, or the sweating may be partial; the respiration is irregular, or stertorous. The excretions are passed involuntarily, and the patient generally dies in a brief convulsive fit.

Morbid appearances.—The characteristic peculiarity is the existence of numerous minute tubercles, of a grayish or yellow colour, scattered over the surface of the brain, in the substance of the pia mater; sometimes the tuberculous matter is in large masses. The free surface of the arachnoid exhibits few signs of inflammation. The pia mater is inflamed, being injected, thickened, and infiltrated, and often exhibiting a deposit of a thick, yellowish matter, supposed to be coagulable lymph or pus.

The cerebral substance is congested; the convolutions flattened, and even at times quite effaced; the cortical portion is reddened, and the medullary portion, when cut, appears as if sanded over with red specks. The ventricles usually contain an abnormal quantity of serum, which may amount to several ounces; but other cases do not present this lesion, proving that the effusion is not essential to constitute the disease.

Tubercular deposits are also found in various other parts of the body, in a vast majority of cases.

Treatment.—This should be strictly antiphlogistic, and should be resolutely employed at once. Blood should be freely drawn from the arm; below the age of five, it will be more prudent to apply leeches to the temples or behind the ears; but some physicians deem it right to abstract blood from the arm, even in children of three or four years of age. The abstraction of blood must be followed up by free purging; and as the bowels are always constipated, recourse must be had to the most active purgatives, especially calomel and scammony; in many cases, the administration of croton oil will be found necessary to obtain

evacuation of the bowels. During the employment of these means, the head should be shaved, and kept cool by the constant application of cold lotions. Calomel may be administered in small regular doses, till it causes green stools like chopped spinach. Great excitement or delirium may be mitigated by giving very small doses of tartar emetic in solution. When the force of the circulation and the acuteness of the disease have diminished, blisters may be applied to the nape of the neck. In the latter stages, digitalis, colchicum, and a variety of remedies have been recommended, but the case is almost beyond relief. Iodine and iodide of potassium have been confidently recommended, and should be tried, from their known effects in scrofula.

Whatever mode of treatment be adopted, it should be had recourse to at the very onset of the disease, for experience unfortunately shows that little hope of recovery remains when the affection has arrived even at the second stage.

Cerebral exhaustion in children produces many symptoms like hydrocephalus, for which it would be most dangerous to mistake it, as the causes, nature, and treatment are quite opposite. It occurs to children ill fed, or exhausted by depletion: the face is cool; the child very drowsy, and unable to hold its head up; the breathing irregular and sighing. One grand distinctive mark is, that the *fontanelle is sunken*, showing that there is no vascular turgescence in the brain. Beef-tea, small doses of ammonia, good nursing, and warmth, are the remedies.

Chronic Hydrocephalus. — This disease seems to depend, not on inflammation of the cerebral membranes, but on increased secretion of the cerebro-spinal fluid, which is commonly connected with some congenital lesion of the brain. Chronic hydrocephalus generally exists at the period of the infant's birth, but it sometimes appears during the first few years of infantile existence. It manifests itself by a gradual enlargement of the cranium, which occasionally attains an enormous size. The accumulation of fluid within the skull not only distends the bony cavity and impedes its ossification, but separates the bones from each other, leaving spaces at the fontanelles, and in divers other places, which are now merely protected by membranous expansions. The cerebral substance is also more or less injured. In some cases, a great portion of the nervous matter seems to have disappeared; while in others it is spread out in thin layers, which embrace the fluid, as it were, in a sac. The gradual augmentation of the head is the chief sign of chronic hydrocephalus; in addition to this symptom, we find that the infant gradually loses flesh, and becomes dull; manifests signs of suffering in the head; sympathetic vomiting is also frequently observed; and the intellectual faculties and senses gradually become more obtuse. The child is unable to carry the head erect, and the muscles of the face become the seat of convulsive movements. As the disease progresses, the well-known symptoms of compression manifest

themselves more and moie, and the patient dies either in a state of idiocy or in convulsions.

Treatment. — There are only two modes of treatment worth mentioning, viz., gradual compression of the head, and puncture. The former method, which was well known to the physicians of the seventeenth and eighteenth centuries, has been recently revived by Sir Gilbert Blane; while the happy results of puncture, through the anterior fontanelle, sufficiently justify us in having recourse to this operation as a probable means of cure. Compression should be well kept up after the operation.

ENCEPHALITIS—CEREBRITIS—INFLAMMATION OF THE BRAIN.

Causes.—Long exposure to a vertical sun, anxiety of mind, the inordinate use of ardent spirits, cold, fright, external injury, the sudden disappearance of an old discharge, &c., may produce this disease; it sometimes occurs as consequent on small-pox, or erysipelas of the face and scalp, and fevers, especially those of a typhous character, &c.

Symptoms.—Violent inflammatory fever, hot and dry skin, flushed countenance, suffused eyes, quick and hard pulse, throbbing of the carotids, and delirium. The senses are morbidly acute, there being intolerance of light and sound. The person is extremely restless; there is jactitation of the limbs, and rigidity of the muscles; the head is remarkably hot, the pupils contracted, and the excretions and secretions are suppressed. Occasionally, the muscles of the face are spasmodically affected, the upper eyelid hangs down, and the commissures of the lips seem to be drawn to one side. The tongue is white, loaded, red at its edges, and the papillæ elevated; there are nausea, vomiting, and obstinate constipation of the bowels. This last symptom is common in congestion, or inflammatory affections of the brain.

As the disease advances, all these symptoms are reversed; the morbid acuteness of the sensation changes into blindness and deafness; the delirium passes into stupor, and gradually into coma. Convulsions and different forms of paralysis ensue; the countenance is vacant or idiotic; the eye loses its lustre; the pupils become dilated; and occasionally there is strabismus. The respiration is now irregular, occasionally stertorous, the articulation imperfect, the pulse frequent and small, the limbs spasmodically convulsed or paralytic; there are retention of urine, and involuntary discharge of the fæces. In the still more advanced stage the countenance becomes pale and sunken, the pulse weak and irregular, the urine passes off involuntarily, the skin becomes cold and clammy, the coma more profound, and death soon closes the scene.

Morbid appearances. The inflamed part of the brain presents different appearances, according to the time the disease has lasted. When it is only of some days' duration, the white substance, and still more perceptibly, the gray, exhibits a rosy, or slight red colour; and in it

we perceive several vascular filaments. The firmness of the affected part is considerably diminished, and when cut into, the surface of the incision presents a number of small red points, which cannot be removed by ablution.[1] In a more advanced stage of encephalitis, the brain is red, the vascular injection more strongly marked, and the softening very considerable. Finally, in some cases, the blood becomes so intimately mixed with the cerebral substance, that its colour approaches that of the lees of wine, being of a deep dusky red; there is no actual effusion of blood, except we consider as such some small dots, about the size of a pin's head, which we occasionally find in some particular points; in such cases, the brain is in a state of extreme *ramollissement.*

Should it happen that the inflammation passes into these stages without causing death, then the part affected begins gradually to lose its softness, and ultimately becomes more dense than in the natural state; it retains for some time its red colour, but finally changes to a dusky yellow.

The third stage of encephalitis is that of suppuration; the red colour gradually disappears, and the blood is replaced by a sero-purulent fluid, which is infiltrated into the substance of the brain, combines with it, and gives to it, according to the extent of the admixture, a grayish, dull white, or yellowish-green colour. Sometimes the pus is found in small isolated spots; at other times small distinct cavities form, and occasionally we find several small cavities uniting to form a large one. In some instances, the pus is found enclosed in cysts, in which case the purulent matter assumes the same characters as that found in the cellular membrane of the body. The gray substance is the most usual seat of encephalitis; and the parts most commonly affected are, the corpora striata, optic thalami, the convolutions, pons Varolii, and cerebellum.

Treatment.—In this case, the most active treatment must be had recourse to. The patient should be bled to the approach of syncope; the head should be shaved, and leeches applied to the scalp, or cupping to the nape of the neck. There is great tolerance of the loss of blood in this case, and it is extremely difficult to produce syncope, owing to the excited condition of the brain producing a continued determination of blood to that organ. Cold should be applied to the head, and this treatment is indicated in all cases of meningitis, and meningo-encephalitis, except in the rheumatic or erysipelatous forms. The bowels should be well emptied in the first instance by a large dose of calomel, and compound extract of colocynth, followed in about two hours by a brisk cathartic draught, aided in some instances by a purgative enema. Having procured a proper action of the bowels, repeated doses of calomel should be exhibited, either in combination

[1] These small red spots differ from those of congestion, in which small drops of blood reappear, as soon as the first are wiped away.

with digitalis, colchicum, or an antimonial; and its action should be established in the system as quickly as possible. During the progress of the disease, enemata and brisk cathartics should occasionally be administered. In the advanced form, should there be deep coma, blisters to the scalp have been recommended.

Blisters, however, should never be applied in this situation, unless there is profound sopor, weak action of the carotids, and no remarkable increase of temperature of the head. If applied in the earlier stages, they seem to add to the excitement. Sinapisms may be applied to the feet, or inner sides of the legs or thighs; blisters are generally applied to the nape of the neck, or between the scapulæ.

DELIRIUM TREMENS — DELIRIUM C. TREMORE — MANIA A POTU.

The *brain fever of drunkards* (Armstrong) is variously modified, according to the causes in which it originates, and the habits and constitution of the patient. It may, however, be divided into two species, the one being evidently connected with inflammatory irritation, or with excited vascular action in the meninges of the brain, and associated with great irritability; the other consisting chiefly of this last state, attended by exhausted nervous energy. The former occurs usually after a protracted debauch; the latter from the suspension of the stimulus in more habitual drinkers.

Symptoms.—The phenomena of this disease vary remarkably, from the slightest forms of nervous tremor, with spectral illusions and accelerated pulse, to the most alarming state of vital depression, muscular agitation, and mental alienation. In ordinary cases, it is characterized by constant watchfulness, and tremulous quivering motion in the lips, hands, and muscles, generally, on making any effort. The pulse, which is at first slow, becomes quick; there is a constant disposition to talk, now on one subject, and now on another. In the first variety mentioned, the pulse is full and hard, the skin dry, the delirium furious, the eyes injected, the temperature of the head increased, and the tongue is often dry, and red at its edges. In the second form, which is the most common, the pulse is small, or soft, and ranges between 100 and 120; the face is not flushed, nor the skin hot, but is covered with a clammy perspiration. As the disease advances, the mental delusion becomes constant, and is generally of a low or melancholic kind, with continued reference to the patient's ruling passions and occupations, and anxiety respecting them. He is perpetually haunted by frightful creatures, or occupied with the most extravagant ideas, and is continually endeavouring to avoid them. If a favourable change do not now take place, the skin becomes more cold and clammy, and exhales a peculiar smell, which is between a vinous and alliaceous odour; the pulse becomes still more frequent, small, weak, and thready, so that it cannot, in some cases, be counted; the general tremor increases; the patient talks incessantly, and with great ra-

pidity; the delirium increases, and the patient either sinks into the calm which sometimes precedes death, or is carried off in a convulsive effort.

Morbid appearances.—The appearances on dissection give no direct information on the nature of this disease. In the true delirium tremens, the *membranes of the brain* evince but little change, the chief lesion consisting of slight opacity of the arachnoid, especially at the base of the brain. The pia mater is more or less injected, and an effusion of serum is occasionally observed in the ventricles. In those cases which have accompanied or directly followed intoxication, the vessels are often much congested, particularly those of the velum interpositum; the arachnoid is thickened, and the serum is more abundant, and occasionally is even sanguineous. The appearances of the *stomach* and *liver* are not necessarily connected with the pathology of this disease.

Treatment. —In the form of this disease which is attended with increased vascular action, cupping below the occiput, or leeches behind the ears, will be required; cold lotions, or cold affusion to the head, when its temperature is increased; sponging the body with tepid water; purgatives, judiciously combined with stimulants; and aperient and antispasmodic enemata. When the affection has been caused by spirituous liquors, we should assiduously watch the subsidence of the inflammatory symptoms, and anticipate the depression which ensues; with this intention, tincture of hops or of lupulin, combined with valerian or assafœtida may be given. Moderate doses of *opium*, or of laudanum, with the view of lessening nervous irritability and inducing sleep, should also be exhibited. Or tartar emetic may be given in combination with opium, with the view of quieting both nervous and vascular action.

In the treatment of the second variety, or the *true delirium tremens*, we should endeavour to cut short the disease by giving *opium*, with full doses of *camphor* and *ammonia*, and administering enemata, containing laudanum and assafœtida. Many recommend the accustomed stimulus in moderate quantity and at short intervals; it may, however, cause too violent reaction, unless the head be guarded by having frequent recourse to cold affusion. In some cases, warm spiced negus, or punch, may be allowed. The great object is *to procure sleep*, after which, the danger is over. Stimulating liniments applied over the epigastrium are occasionally very efficacious. When the symptoms of nervous irritation have been allayed, we should direct our attention to the condition of the gastro-hepatic system; in which, frequently, there is derangement of function. By the judicious combination of stimulants and medicines which will act on the liver, such as calomel or camphor, and stimulating purgative draughts, we again restore the proper secerning action of this gland, and dissipate any sanguineous injection or infarction of its structure. Having produced a proper action on the alimentary canal, we may again have recourse to opium

if any signs of irritation remain. The use of opium is much abused in this disease, and in many cases it is pushed to a most unjustifiable extent. *It is an important question, In how many cases of delirium tremens does the patient die in a state of narcotism?* It is certain that the use of large and repeated doses of opium promotes the supervention of coma, effusion, and paralysis; and that its effects nearly resemble the phenomena of the last stage of delirium tremens. During the convalescence, mild tonics should be given, the diet should be light and nutritious, and a suitable beverage, in moderate quantities, allowed.

APOPLEXY.

This affection is characterized by loss of consciousness, feeling, and voluntary motion; or, in other words, by a suspension of the functions of the brain, respiration and circulation being also more or less disturbed.[1]

The suspension of the cerebral functions may be connected with any of the following pathological conditions:—1. Great congestion of the brain, in which the vessels of that organ are gorged, but without extravasation of blood or serum; this is termed "*congestive apoplexy.*" 2. Congestion of the vessels of the brain, with extravasation on its surface, forming the "*meningeal apoplexy*" of Serres. 3. Hemorrhage into the substance of the brain, with lesion of its structure. 4. A serous effusion on the external surface, and into the ventricles of the brain, constituting what is defined "*serous apoplexy;*" but this is more frequently the termination of an inflammatory or congestive disorder of the brain, than of that deranged state which constitutes the apoplectic attack. 5. Apoplexy may occasion death without leaving any sign at all in the dead body. To this variety, to which the older writers gave the names of *nervous*, *convulsive*, and *hysteric*, Dr. Abercrombie has applied the term *simple apoplexy*.

Causes.—Apoplexy is said to be hereditary. It may occur at an early period of life, but in the majority of cases the age is above fifty. Among its causes are—ossification, or aneurism of the arteries of the brain; obstruction, thickening, induration, or obliteration of the canals of the sinuses; diseases of the heart, especially hypertrophy of its left ventricle; diseases of the kidney, particularly the granular degeneration described by Dr. Bright; torpor of the liver, or other excreting glands; diseases of the air-tubes and lungs, especially those attended with violent fits of coughing; the *coup de soleil;* suppressed hemorrhages, particularly epistaxis and hæmorrhoids; suppression of the menstrual discharge; metastatic gout and rheumatism; suppression of any vicarious discharge; depressed and anxious states of the mind; excessive use of wine or malt liquors; too great sexual indulgence; frequent indulgence in sleep after a full meal; the use of neckcloths worn too tightly around

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[1] Dr. Copland's Dictionary.

the neck, &c., are among the predisposing causes of apoplexy. Gastric disease, narcotics, and mephitic gases may also be enumerated. Overloading the stomach and neglecting the bowels are often enough to cause an attack in the predisposed.

Apoplexy is said to occur chiefly in persons of a full habit of body. Upon this point, M. Rochoux's cases afford important data. Of his sixty-three patients, thirty were of an ordinary habit of body, twenty-three were of a thin, meagre habit, and ten only were large, plethoric, and fat.[1]

Symptoms (premonitory).—Apoplexy is sometimes preceded at considerable intervals by precursory or warning symptoms, such as vertigo, headache, ringing in the ears, loss of memory, a feeling of drowsiness and lethargy, depraved vision, or partial palsy. In some cases, there is a sense of great fulness in the head, the veins of the head and forehead become turgid, the countenance is suffused and occasionally livid, and there are slight attacks of epistaxis. If any individual were to complain of several of these symptoms at any period of life, he might be regarded as on the very brink of some serious affection of the brain; and if the person be in the decline of life, it may safely be said he is in immediate danger of an attack of apoplexy. But it is a serious error to suppose that premonitory symptoms always occur; indeed, if we may trust the experience of M. Rochoux, one of the best authorities on apoplexy, they are by no means common. Of *sixty-three* cases which came under his notice, *nine* only had distinct precursory symptoms.[2]

Symptoms of the attack.—In the *mild* form of apoplexy (the *atonic* apoplexy of Dr. Good), the patient, after experiencing some of the premonitory symptoms, is seized with alarming vertigo, leipothymia, or feeling of faintness; nausea and vomiting; disturbance of the senses, particularly of the sense of sight; loss of memory; partial loss of sense, consciousness, speech, and voluntary motion; weak, irregular, and sometimes quick pulse, and more or less of sopor.

In the *more active form* (the *entonic* apoplexy of Dr. Good), the patient is more or less suddenly seized with profound sopor, the eyes being either opened or closed; the breathing deep, slow, sonorous, or stertorous; and the pulse slow, full, hard, or strong, sometimes irregular. In this form of the disease, the above are often the chief symptoms, there being no paralysis; but frequently the mouth is drawn to one side, the eyes are distorted, and one eyelid immovable, with relaxation, loss of sensation and of motion of a limb, or of one side of the body; the arm of the non-paralysed side being often closely applied to the chest or to the genital organs. The patient generally lies on the paralysed side, which is relaxed, incapable of motion, and insensible to the application of irritants.

In the *most severe and sudden* forms of attack, the patient is struck

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[1] Recherches sur l'Apoplexie, p. 214. [2] Loco citato, p. 70.

down instantly, sometimes froths at the mouth, has a livid countenance, dilated pupil, complete relaxation and immobility of the voluntary muscles and limbs, and unconscious evacuation of the urine and fæces, and dies very shortly afterwards either with or without stertor, with cold, livid extremities, cold perspiration, and sometimes a cadaverous cast of countenance. This form constitutes the *apoplexie foudroyante* of the French, in which there is generally an immense extravasation of blood.

Duration of the symptoms in fatal cases of apoplexy. — According to the common opinion, apoplexy may prove fatal instantly, or in a few minutes. The best modern pathologists deny this, and assert that when death is so sudden, the cause is commonly disease of the heart, and never apoplexy. Although, however, it seldom proves instantaneously fatal, it may undoubtedly cause death in much less than an hour. In some cases, on the other hand, patients remain even for months in a comatose, paralytic state.

Of serous apoplexy. — It was once supposed in certain cases not attended with evidence of vascular excitement, that the symptoms were owing to an *effusion of serum;* hence they were called serous apoplexies; but this distinction is now abandoned.

Diagnosis between serous and sanguineous apoplexy. — The sanguineous was said to be distinguished by flushing of the countenance, and strong pulse, and by occurring in persons in the vigour of life; the serous, on the other hand, was said to attack the aged and infirm, the countenance being pale, and the pulse weak, in such cases. But there are many cases whose symptoms and circumstances come exactly within the description of the *serous apoplexy,* but still after death present the vasculer engorgement, &c., of the sanguineous, whilst no serous fluid is effused. Speaking of these distinctions, Dr. Abercrombie observes, "It will be found that many of the cases which terminate by serous effusion, exhibit in the early stages all the symptoms which have been assigned to the sanguineous apoplexy; while many of the cases which are accompanied by paleness of the countenance and feebleness of the pulse will be found to be purely sanguineous."

Morbid appearances. — Effusion of blood within the cranium may take place in the brain or cerebellum; in their crura; in the pons Varolii, and in the medulla oblongata; in the corpus callosum; in the ventricles; on the surface of the brain beneath the pia mater; in the cavity of the arachnoid; between this membrane and the dura mater, which it lines; and between the dura mater and cranium.

It has been found that certain parts of the brain are much more liable to sanguineous effusions than others.

M. ROCHOUX'S DISSECTIONS.—FORTY-ONE CASES.

Extravasation of blood on the		*left side*	18
Do.	do.	*right side*	17
Do.	do.	*both sides*	6
			41

OF THE SITUATIONS OF THE EFFUSIONS.

In the corpora striata	24
optic thalami	2
In both these situations	1
Under the corpus striatum	1
In the middle of the hemispheres	5
posterior part of the ventricles	2
anterior and interior part of the hemisphere	2
posterior and interior part	3
middle lobe	1
	41

By this table it is shown that out of forty-one cases of effusion, twenty-eight were in the corpora striata and their vicinity.

A SUMMARY OF THE RESULT OF 386 CASES OF APOPLEXY, FROM THE PRECIS D'ANATOMIE PATHOLOGIQUE OF ANDRAL.

SEATS OF THE EFFUSION.

In the substance of the hemispheres, on a level with the corpora striata and optic thalami	202
corpora striata	61
optic thalami	35
hemispheres above the centrum ovale	27
lateral lobes of the cerebellum	16
brain, anterior to the corpus striatum	10
meso-cephalon	9
spinal cord	8
posterior lobes of the brain	7
middle lobe of the cerebellum	5
peduncles of the brain	3
olivary bodies	1
peduncles of the cerebellum	1
pituitary gland	1
	386

On reference to this table, it will at once be observed the vast preponderance of cases in which effusion has occurred into the hemispheres of the brain, the corpora striata, and the optic thalami.

Treatment.—In the treatment of apoplexy, with active determination to the head, full labouring pulse, carotids beating strongly, &c., the first indications are to relieve the head from the accumulation of blood, to prevent further congestion, and to obviate inflammatory action: and for these purposes the only efficient means is *bleeding*. A full bleeding, then, must be immediately employed; the head should be shaved and freely leeched, and the patient may be cupped on the temples or the back of the neck. The administration of brisk *drastic cathartics* is attended with the best results, their *derivative* action being a powerful means of relieving the coma. Croton oil is the purgative generally used in these cases; but where the patient can swallow

other drastic cathartics may be given. Where the patient has completely lost the power of deglutition, the croton oil should be mixed with a little castor oil or mucilage, and passed into the œsophagus by means of an elastic tube. Drastic *enemata* will also be found beneficial. The head must be kept cool by means of *cold lotions*, *iced waters*, or by pouring a small stream of cold water on the scalp occasionally. When the coma is persistent, *blisters* should be applied to the nape of the neck, or to the head; sinapisms to the feet are also indicated. But it must yet be remembered that there is injury done to the brain; that a portion of its substance has been torn up, and compressed by a clot of blood; and that this injury has to be repaired. Hence, the indiscriminate use of the lancet, draining the patient's veins after all active congestion has ceased, is much to be reprobated. Something must be allowed to time, and the powers of nature.

If the patient's face is cold, the carotids beating feebly, and the patient approaching a state of syncope, considerable caution must be used in abstracting blood. Purgatives should first be given, with small doses of ammonia, and sinapisms be applied to the feet; when the circulation has recovered its force, blood may be taken by cupping from the nape of the neck, and blisters be applied behind the ears, or to the nape of the neck.

When an attack of apoplexy is known to follow habitually if the stomach is loaded with indigestible food, an emetic of sulphate of zinc may be given, as it evacuates the stomach with the least possible straining.

PARALYSIS.

The most characteristic symptom of cerebral hemorrhage is paralysis. Very slight effusion produces this effect, and in general its intensity is in the direct ratio of the extent of the effusion. Paralysis may also arise from diseases of the brain, or its membranes, injuries of the brain or the spinal cord, diseases of the spinal cord or its membranes, pressure on, or injury of, the large nervous plexuses, the action of lead, &c.

Paralysis has been divided into several varieties:—1st, paralysis of the nerves of motion: 2d, paralysis of the nerves of sensation; 3d, *hemiplegia*, which implies the existence of paralysis on one side of the body; 4th, *paraplegia*, which signifies that the lower extremities are paralysed; and 5th, *partial* paralysis, as of the muscles of the mouth, or of an extremity; 6th, *general* paralysis, when the two sides of the body, whether in their entire extent or in some of their parts, are at once deprived of motion.

PARALYSIS FROM CEREBRAL HEMORRHAGE.

This form of paralysis developes itself at the very moment the effusion of blood takes place in ordinary apoplexy; acquires all at once its highest degree of intensity; then remains stationary, or begins to di-

minish. Sometimes the paralysed part has not previously experienced any disturbance with respect to either sensation or motion; sometimes, on the contrary, the patient has experienced in these parts pricking sensations, numbness, permanent or transient, an unusual feeling of cold, a sense of weight, and a certain degree of debility. These different phenomena may announce two things: either the existence of constant lesion in the same point of the brain where, at a later period, the hemorrhage shall take place,—as simple habitual sanguineous congestion; a softening which is still inconsiderable; or a tumour; or else the more or less frequent return of a more serious congestion in the part of the brain where the blood is to be effused.

The paralysis following cerebral hemorrhage presents great varieties with respect to its seat, and pathological anatomy is far indeed from being always able to assign the cause of such numerous varieties.

There has not as yet been established any *special* relation between the seat of the effused blood and the paralysis of particular organs. It has been asserted that paralysis of the *superior* extremities depends on the effusion taking place in the *thalami*, or in the cerebral substance situated on a *level* with, and *posterior* to them; and that paralysis of the *inferior* extremities depends on the effusion taking place in the *corpora striata*, or in the cerebral substance situated on a *level* with, or *anterior* to them. It is certainly true that cases occur in which the relation of the effusion and the paralysis as above stated holds good; but again, there are numerous cases which fully demonstrate, that paralysis of the extremities has no necessary connexion with effusion into these portions of the brain.

It has also been asserted that *loss of speech* depends on the effusion occupying the *anterior lobes* of the brain; but this observation derives still less support from actual experience than the former, for blood may be effused into the anterior lobes of the brain without giving rise to any modification of speech.

The best established facts regarding the seat of cerebral hemorrhage, and the relation which exists between it and paralysis, are the following:—

1. That the paralysis almost always occupies the side of the body opposite to that of the brain or cerebellum in which the effused blood is situated.

2. That the paralysis affects only one side of the body when the effused blood is confined to one hemisphere of the brain, or one of the lateral lobes of the cerebellum.

3. That the paralysis exists on both sides of the body when the hemorrhage has taken place in both hemispheres of the brain, or both lateral lobes of the cerebellum, into the ventricles, the pons Varolii, the medulla oblongata, and on the surface of the brain.

4. That paralysis of both sides of the body may also take place when the hemorrhage is confined to one hemisphere of the brain or lateral

lobe of the cerebellum, but is so extensive as to produce compression of the opposite hemisphere or lobe.

A most remarkable circumstance, connected with cerebral hemorrhage, has been observed by Andral, viz., hemorrhage of one of the lobes of the cerebellum, like that of one of the hemispheres of the brain, gives rise to paralysis of the opposite side of the body; but if hemorrhage takes place into the *left* lobe of the cerebellum, and *right* hemisphere of the cerebrum, the paralysis is found to exist on that side opposite to the hemisphere of the cerebrum, which is the seat of the effusion, the other side remaining unaffected by the effusion in the cerebellum.

When the blood is effused into the substance of the brain, its colour gradually changes from red to black, and in successive transitions to brown, dull green, orange, pale yellow, or yellowish white. When the clot has undergone the latter changes of colour, and the fibrine, separated from the other constituents of the blood has assumed a fibrous or laminated appearance, the blood-vessels are observed to form in it. The fibrine may retain its distinctive characters for some time, and then become converted into firm fibrous tissue, which, gradually diminishing in bulk, forms eventually a small cicatrix; or, the organized fibrinous substance may be converted into a loose cellular tissue, filled with a serous fluid (the *apoplectic serous cyst*), and traversed by a considerable number of blood-vessels. Should the case, under these circumstances, proceed favourably, the serum of the cyst becomes absorbed, the walls approximate, and a cicatrix is formed. Finally, if a complete cure of the paralysis is effected, the cicatrix, whether formed by the first or last process described, disappears.

Treatment. — The treatment of paralysis dependent on cerebral hemorrhage consists at first in the treatment proper for the different varieties of apoplexy; and afterwards in the use of derivatives, and finally, general and local stimulants. The patient should be restricted in his diet, and all causes of cerebral excitement, whether physical or moral, should be avoided; the chief object in the first part of the treatment being to promote the absorption of the clot, which is best effected by moderately lowering the cerebral circulation. Much advantage is derived from the insertion of a seton, or an issue, in the neck, which establishes a kind of drain in the vicinity of the disease. The bowels should be well acted upon, and the condition of the bladder attended to. When the organic disease of the brain is removed, and all symptoms of vascular excitement or congestion have disappeared, we may have recourse to *strychnia*. This substance, being a powerful medicine, should be given in doses of one-sixteenth of a grain at first; however, it may be gradually increased to half a grain, or even a grain in a day. Whenever it produces headache, vertigo, sickness of the stomach, and violent spasmodic twitchings, it must be discontinued.

The *local treatment* consists in rubbing the parts with stimulating liniments, applying blisters to the spine, or along the course of the

nerves, sprinkling the abraded surface with strychnia, and, finally, in using electricity. The use of the moxa has been strongly recommended; if the paralysis exists in the lower extremity, it may be applied in the course of the great sciatic nerve; if in the upper extremity, it may be applied to the back of the neck, corresponding to the junction of the brachial nerves with the spinal cord.

TETANUS—LOCKED-JAW.

This is a spasmodic disease, in which the muscles are in a state of rigid contraction, with intervals of partial relaxation, without coma, or any disturbance of the intellect.

It has received different names, according to the effects of the spasm, as, *trismus*, when the muscles of the jaws are involved; *opisthotonos*, when the body is curved backward; *emprosthotonos*, when the curvature is forward; and *pleurosthotonos*, when to one side.

Tetanus is also divided into the *idiopathic* and *symptomatic;* when the latter is the effect of wounds, or other external injury, it is named *traumatic tetanus.*

Symptoms, course, &c.—Various premonitory signs of an uncertain character are alluded to, but the first unequivocal symptom is a feeling of uneasiness and stiffness in the back of the neck and jaws, with pain on attempting to open them; and sometimes a difficulty in swallowing. Afterwards there is pain the epigastrium, shooting towards the spine, and then of the muscles of the face and trunk, which become more or less permanently rigid and hard. Besides this rigidity, there are paroxysms of spasm, alternating with partial relaxation; these spasms gradually increase in violence and duration, and produce excessive pain; they are brought on by the slightest cause.

The *voluntary* muscles appear to suffer most; but the involuntary are also affected towards the close of the disease.

Nearly all the *functions* suffer. Deglutition is more or less difficult; the bowels are constipated; respiration is embarrassed, sometimes so much as to cause death from apnœa. Spasm of the glottis often occurs; the action of the heart is accelerated. There is no fever, though the temperature of the surface is elevated several degrees above the usual point. The mind continues remarkably clear throughout the disease. Death may occur from the first to the fifth day, either from apnœa, arising from spasm of the glottis, or immobility of the respiratory muscles, from pure exhaustion, or possibly from spasm of the heart.

A particular variety of tetanus occurs in new-born children, called *trismus nascentium;* it is especially common in the West Indies among the negroes, and is usually ascribed to irritation arising from cutting the cord, though doubtless owing to some predisposing cause, as foul air, &c.; it is always fatal.

Nature and cause.—Tetanus is the result of an irritation of the spinal centres, whether originating therein, or reflected thereto from

the nervous extremities; the latter is the most usual condition, as when a splinter inserted under a fascia transmits the irritation to the spinal centres, from which the motor force is sent into the various muscles involved in the spasm. *Inflammation* is certainly not the cause; for in true spinal inflammation we have the opposite result, or *paralysis.* Frequently there is no lesion of the nerve-centres discoverable after death; though, in other instances, there are marks of inflammation or congestion in the meninges of the spinal marrow, and also in the nerves proceeding from the wound. There must also, it would appear, be a peculiar predisposition, since comparatively few of those who are exposed to the exciting causes, are attacked with the disease. It is not known in what this predisposition consists; but it is favoured by the long-continued prevalence of heat, and hence is much more common in tropical countries. Males are more liable to it than females; and the age most exposed to it is from ten to fifty.

Of the *exciting* causes, may be enumerated wounds and injuries, particularly lacerated and punctured wounds, meningeal inflammation, nux vomica or strychnia; and, of the idiopathic, exposure to cold when the body is heated.

Treatment.—The traumatic form is much the most dangerous. The indications are:

1. *To remove all known causes of irritation.*—As by the application of an anodyne emollient poultice to the wound, &c.; clearing out the bowels by stimulating cathartics; bleeding, if it is accompanied with inflammation.

2. *To diminish the susceptibility of the nervous centres*, by *very large* doses of opium, or the extract of Indian hemp. *Belladonna ointment* applied endermically to the spine is asserted to have proved effectual after other remedies failed.

3. *To diminish directly the nervous irritation* by the use of tobacco enemata, or the tincture or extract of aconite internally; the cold bath; or by powerful revulsives, or ice applied to the spine; Dr. Hartshorne recommended a solution of caustic potassa (ʒij in fʒiv of water.)

4. *To support the patient's strength*, by nutritious diet and cordials.

In consequence of the closure of the jaws, the food must be introduced, in a liquid state, either between the teeth, or, if necessary, by removing one or more of them; and in case of inability to swallow, through the stomach-tube.

EPILEPSY.

Causes.—Epilepsy appears to be occasionally hereditary, but it is more frequently an acquired disease. It generally arises from excessive nervous irritation, either induced by sympathetic influences, or by direct causes. As examples of the former, may be enumerated, gastro-intestinal disturbance from indigestible food, worms, &c.; difficult dentition; uterine irritation; excessive sexual intercourse and masturba-

tion; the abuse of spirituous and fermented liquors; the presence of calculi in the kidney, ureter, or bladder, or of gall-stones in the excretory duct of the liver. The direct causes are—injuries of the head or spine; diseases of the cranial bones or of the vertebræ; tumours growing on the bones, or spiculæ of bone protruding into the brain; ossific deposition in the dura mater or its processes; ossification of the arteries of the brain; concussions of the brain or spinal cord; and metastasis of gout or rheumatism to the encephalon. Dr. Meade is convinced that the relative frequency of disease of the spinal cord and its membranes in this affection is underrated; and that much may be done for the patient in many instances by attending to the state of this part of the nervous system. The other causes which have been enumerated are—fright, fits of passion, distress of mind, appalling sights, seeing others in the paroxysm, excessive hemorrhage, immoderate depletion, hypercatharsis, the suppression of eruptions, irritation of remote nerves, and the syphilitic and mercurial poisons. Its causes may be divided into, 1st, the *centric*, consisting of disease, or causes of irritation in the nervous centres; 2d, the *eccentric* or *peripheral*, consisting in causes of irritation in the viscera or external parts.

Symptoms.—Epilepsy is generally a chronic disease, and frequently ends in insanity; it sometimes, however, proves fatal during a paroxysm. It consists in fits of *unconsciousness* and *convulsions*. The epileptic fit is *occasionally preceded by certain warnings*, such as stupor, a sense of coldness, or creeping, or of a gentle breeze (*aura epileptica*) proceeding from a particular part of the body towards the head. M. Georget states, "that warnings do not occur in more than five cases in a hundred;" this is, however, underrating their frequency.

In most cases, the patient utters a cry and suddenly falls senseless; the eyes are opened widely, the pupils are fixed, the face is drawn to one side, and the jaws are firmly closed; after some minutes, the muscles of the neck become rigid, the jugular veins distended, and the face is in a state of livid turgescence; the muscles of the face are now seized with frequent spasmodic contractions; there are convulsive movements of the extremities, particularly the superior; the thorax is fixed and the respiration is exceedingly difficult. The tongue is sometimes thrust with violence out of the mouth, and is occasionally caught between the teeth, and severely bitten; in this case the frothy matter expelled from the mouth is tinged with blood. To this state, which may last from a few minutes to a quarter, or even half an hour, succeeds a deep sleep, general relaxation of the muscular system, paleness of the countenance, and a gradual return of free respiration; the countenance for some time retains an expression of stupidity; the intellectual and sensorial faculties, however, gradually resume their activity, the patient at the same time experiencing a creeping sensation all over his body. Occasionally it happens that one fit succeeds another, till the patient becomes comatose, and dies; but comparatively few die

during a fit, unless the disease has existed for a considerable time. In some cases, the attack is much less violent, and consists merely of a momentary loss of sense, with slight and partial convulsions of the eyes, mouth, upper extremities, or fingers, and may or may not be accompanied by a fall.

The most frequent *complications* of epilepsy are, apoplexia, mania, paralysis, chorea, hysteria, and catalepsy; hence the morbid appearances are infinitely various.

Morbid appearances.—Epiplepsy may be connected with any of the organic lesions which occur in the brain and cranium. When a patient dies in a fit of simple epilepsy, the substance and the membranes of the cerebrum and cerebellum are found gorged with black blood. In complicated cases of epilepsy, especially with mania, the medullary substance of the brain is found indurated, and its vessels enlarged; occasionally, however, with dilatation of its vessels, it is softened and flabby. These structural changes are generally limited in extent. The cortical structure also occasionally presents evidence of chronic inflammation, and is, in some instances, adherent to the membranes. The medulla oblongata and spinal cord present, in many cases, alterations similar to those found in the encephalon. The Wenzels found *the pituitary gland* and *infundibulum* variously altered in colour, size, and consistence, in nearly all the cases of epilepsy which they examined; and the crista galli of the ethmoid, and the clinoid processes of the sphenoid bone, more or less prominent, or otherwise changed in position and shape, in most of them. In the larger proportion of eases, the *pineal gland* was also changed in colour, and softened. Caries, thickening, internal exostoses, spicula, malformations, and malpositions of the bones at the base of the skull, with various changes of the membranes, were met with in the larger proportion of cases. The heart, pericardium, lungs, liver, and kidneys, have been found diseased in rare instances.

Treatment.—But little can be done for the patient during the paroxysm, except placing him in the horizontal position, and preventing his being injured by the violence of his muscular exertions. One of the first things to be done is to put something between the teeth, to prevent injury to the tongue, and the dress must be loosened, particularly stays and neckcloths. *Bloodletting* has been recommended in the paroxysm; but unless the fits are attended by marked plethora or cerebral congestion, or in the first attack, especially when produced by the suppression of some sanguineous evacuation, it should be deferred. It is in the convulsive stage of the paroxysm that bleeding is particularly indicated; it cannot, however, be easily performed in this stage. *Cold affusion* to the head has been recommended by Brera; it is not very efficacious, except in those cases complicated either with hysteria or uterine disease. *Antispasmodic* and *purgative enemata* are perhaps the most efficacious means during the fit; if there be not much determination to the head, assafœtida injections and castor oil may

be employed; but when this symptom is present, turpentine should be preferred.

After the paroxysm is over, the patient should be kept quiet, the bowels opened as quickly as possible, and light nourishing diet in moderate quantity is to be used; the abuse of stimulants is to be abstained from; and every cause, corporeal as well as mental, which can possibly have the effect of disturbing the balance of the circulation, or exciting the nervous system, is to be avoided. If there be evidence of much disturbance in the cerebral circulation, the treatment must be more active; if the patient's strength will admit of it, *general bleeding* from the arm may be useful, or occasional *cupping* may be had recourse to, together with keeping the head shaved, applying cold lotions, acting briskly on the bowels, and placing moxas or blisters behind the ears, or setons in the neck. In this form of the affection, Dr. Cheyne recommends *James' powder* to be taken at bedtime, beginning with two or three grains, and increasing the dose every night, until a sensible effect is produced on the skin, stomach, or bowels. When chronic inflammatory action is suspected, the *tartar-emetic ointment* should be applied along the spine, or over the nape of the neck, until it produces a copious eruption of pustules. Where this disease arises from an affection of the spinal cord or its membranes, it will necessarily require either vascular depletions or tonics, or both, according to the degree in which plethora, increased action, or deficient power, is inferred to be present. Where incited action exists, cupping, the application of leeches, and dry cupping in the course of the spine, the insertion of setons or issues a little below the seat of the pain, or application of moxas, are the most efficient means. The effects of these means are increased by absolute rest, the antiphlogistic regimen, and active purges. In some cases, associated with deficient power, whilst moderate local depletion, dry cupping, external derivation, &c., are resorted to, *tonics* and *antispasmodics*, such as valerian, castor, myrrh, cinchona, camphor, and the preparations of iron, should be prescribed. This state of disease is often induced by masturbation; in which case cold aspersion of the genitals night and morning, sponging the spine with cold salt water, or vinegar and water, and the internal use of the preparations of iron, will prove beneficial. Where epilepsy occurs in a scrofulous habit, the iodide of iron, or the iodide of potassium, may be given. If worms be suspected, turpentine and other anthelmintics must be exhibited. The diseases of the digestive organs, and the other complications of epilepsy, should be treated on general principles.

Some medicines have been much lauded in the treatment of epilepsy; the principal of these are—the nitrate or oxide of silver, the ammonio-sulphate of copper, arsenite of potash, sulphates of iron, zinc, or copper, quinine, extract of nux vomica, and strychnia. Among the antispasmodics employed are, ether, ammonia, camphor, musk, castor, assafœtida, galbanum, valerian, and serpentaria.

CHOREA.

This disease is popularly named St. Vitus's dance, *Chorea Sancti Viti;* the French call it the dance of St. Guy; and the Germans, the dance of St. Weit.

Exciting causes.—The most common are, intestinal irritation from worms or morbid accumulations, and fright. It may also be caused by injuries to the nervous system from blows or falls; by suppression of eruptions, or vicarious discharges; by rheumatic metastasis to the membranes of the spinal cord; by violent mental emotions; by excessive venery; by masturbation, &c.

Symptoms. — Generally speaking, convulsive movements, or rather twitches, of the fingers and muscles of the face are first observed; after a short time, the convulsive movements become more marked; strange contortions of the features take place; the disease extends to the voluntary muscles of all parts of the body, and frequently those of the lower extremities are so continually excited that the patient appears to be dancing, which makes his gait very unsteady; he is chiefly affected when he is most desirous to control his actions. The disease is sometimes confined to one side of the body, or to a single part, as the face, a leg, or an arm; the muscles are also affected with a sensation of pricking, creeping, or of numbness. At first there is no constitutional derangement, there being no fever, and all the functions being properly performed, with the exception of the bowels being torpid; but after the disease has continued some time, the general health becomes impaired, and occasionally the mental faculties suffer. This affection is much more common in the female than the male, the proportion being, according to the best authorities, three of the former to one of the latter. It most frequently appears between the age of seven and fifteen.

The *nature of the disease* is but very little understood; by several writers it is attributed to inflammatory action of some part of the cerebro-spinal axis; most probably it is due to some perverted action of the *cerebellum.*

The *seat* of this disease is quite as obscure as its nature. M. Serres considers the *corpora quadrigemina* to be the seat of chorea, while MM. Bouillaud and Magendie conceive that it is seated in the *cerebellum,* the functions which they ascribe to this organ being those chiefly affected in this disease.

Treatment.—This consists in removing morbid secretions and fæcal accumulations; in subduing, when evidently present, excited action of the vessels of the spinal cord or brain; and, finally, in rousing the energy of the nervous system. *Purgative medicines* have been prescribed with the best effects in this disease; a full dose of calomel should be given at first, and in a few hours after a brisk cathartic ought to be exhibited. Calomel and jalap are a common combination in this disease; and Dr. Hamilton recommends aloetic pills on the

days when these are not employed. The compound infusions of gention and senna, with a little sulphate of magnesia, may be given in the morning occasionally. The oil of turpentine also forms an excellent medicine in chorea, and is particularly indicated where the presence of worms is suspected. The diet should be light and nourishing; every indigestible substance should be carefully avoided. Dr. Wood recommends the use of black snake-root, having frequently found it of itself adequate to the cure of the disease.

If there be evidence of cerebro-spinal irritation, our attention must necessarily be directed to its removal; this is best effected by cupping, leeches, and powerful counter-irritation, over the parts particularly implicated. Attention to the mental emotions, warm woollen clothing on the lower extremities, cold affusion on the head or on the spine, or the shower-bath, constitute important parts of the treatment.

Boys are said to be more easily cured than girls. In obstinate cases, tonics must be employed, and those generally used in this disease are, bark, sulphate of quinine, arsenical solution, nitrate of silver, sulphate of zinc, the preparations of iron, and the ammonia-sulphate of copper; of the efficacy of the last substance, Dr. Burns speaks highly. The experiments of M. Baudelocque, at the Children's Hospital, Paris, demonstrates that the disease may generally be cured by a persevering use of sulphur-baths. Baron Dupuytren employed cold affusion with much success. The same mode of treatment has been found very efficacious at the Hôpital des Enfans Malades.

HYSTERIA.

This is an apyrexial convulsive disorder, affecting females almost exclusively. The seat of this disease is altogether unknown.

Symptoms.—Hysteria is an intermittent, irregular, chronic disease, which comes on by fits, and usually attacks females from the age of puberty to the critical period; it very commonly occurs on the suppression or diminution of the menses, particularly in persons of a nervous or irritable temperament. In the slighter forms, the patient, without any assignable cause, bursts into a fit of weeping, which perhaps is soon followed by convulsive laughter, which may last for a few minutes; and before composure takes place, the patient gives several loud sobs; one of these fits may succeed the other, till the patient falls asleep. The fit sometimes begins with a yawning, numbness of the extremities, involuntary laughing and crying, alternations of pallor and redness of the face, and a sensation as if a ball (*globus hystericus*) commencing at the hypogastrium, ascended through the abdomen and thorax to settle at the throat, where it produces a violent sense of constriction, and of impending suffocation. In more severe instances of hysteria, there are convulsive movements, particularly of the hands, face, jaws, and muscles of respiration; they are of a clonic character. The pupils are dilated; and occasionally the paroxysm has a close resem-

blance to epilepsy, only that the insensibility is rarely complete. In this disease there is a remarkable deficiency of the organic matters in the urine, and this fluid is very watery. Hysteria does not tend essentially to increase, nor does it determine as a consequence, mania or idiocy. Hysteria is very apt to be confounded with epilepsy.

Treatment.—In those cases where there is reason to suspect any congestion or inflammation of the uterus, or of any portion of the brain, then blood should be drawn by cupping from the back of the head or loins. During a paroxysm, the stays and all tight strings should be loosened, and the free admission of air procured; the face is to be sprinkled with cold water, volatile salts are to be held to the nostrils, and, if the patient can swallow, a drachm of the aromatic spirit of ammonia, or the same quantity of ammoniated tincture of valerian, may be given in a wineglass-full of water. In the severer forms of the disease, the application of cold to the body is often a most effectual means of putting a stop to the paroxysm. The bowels should be kept regularly open, and the best purge in these cases is castor oil with oil of turpentine, given every, or every second morning, according to circumstances; enemata containing assafœtida are also useful. If the convulsion is very protracted, it will be proper to examine the spine, and, if found tender, to apply cups to it. The nauseating effects of tartar emetic are also very beneficial in this condition. The prevention of the recurrence of the symptoms is to be attempted by keeping up an action on the bowels, and administering tonics, such as the sulphate of quinine, the preparations of iron, &c. Fœtids, such as assafœtida, castor, valerian, &c., are sometimes, but not invariably, useful. The menstrual action, if irregular, must, if possible, be rectified by appropriate means. The diet should be light, and every attention paid to the improvement of the general health.

THE END.

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